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# United States Coast Guard Group/Station Operational Information System Proof of Concept Testbed Evaluation Report


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16. Abstract

The Operational Information System (OIS) project is a proof of concept effort sponsored by Commandant (G-T), USCG, to examine ways of improving information flow in U.S. Coast Guard operations. OIS addresses several critical problems facing operational commanders today: redundant data entry, information not available to field personnel, inadequate communications, inadequate resource picture, cumbersome tasking process, stovepipe information systems, proliferation of systems, and multi-level security. OIS could solve these operational problems and enhance mission performance. The USCG R&D Center developed a proof-of-concept testbed to test key system concepts. The testbed focused on reports reduction. There are measurable benefits from a reduction in operational reporting, but they are not large and are also not directly capturable in the budget. The consensus of the Group Commander and senior officers who visited the testbed was that the major benefits OIS could provide the Coast Guard are a result of improved resource utilization. Information would become a force multiplier, allowing better coordination of multi-unit operations. Operational commanders could leverage their assets to greater advantage, especially if OIS were combined with innovative crewing concepts such as the Norwegian Crewing Concept. This would enable business process reengineering such as more centralized command and control, and more centralized resource basing. The resulting organization would include less shoreside infrastructure and fewer coordination personnel. It would also enable covering the same areas with fewer assets.

It appears technically feasible for the Coast Guard to implement the Operational Information System. Most underlying technologies are well developed, with none posing unacceptable technical risk. The highest risk technological areas in a full-scale deployment are distributed database technology and satellite communications. Information technology has matured to the point that the USCG can implement OIS in a cost-effective manner.

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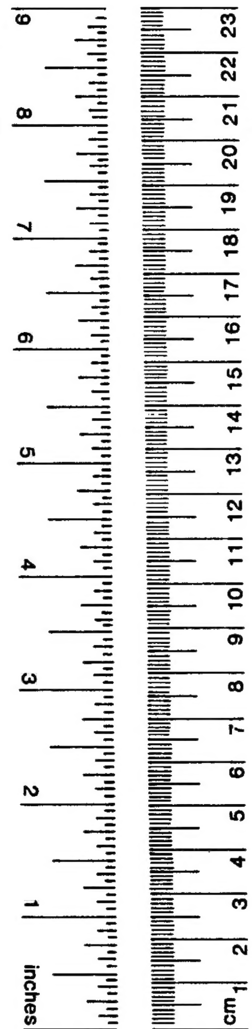
# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

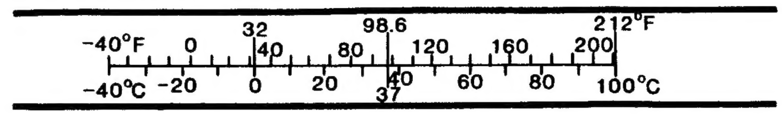
| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| in | inches | *2.5 | centimeters | cm |
| ft | feet | 30 | centimeters | cm |
| yd | yards | 0.9 | meters | m |
| mi | miles | 1.6 | kilometers | km |
| | | **AREA** | | |
| $in^2$ | square inches | 6.5 | square centimeters | $cm^2$ |
| $ft^2$ | square feet | 0.09 | square meters | $m^2$ |
| $yd^2$ | square yards | 0.8 | square meters | $m^2$ |
| $mi^2$ | square miles | 2.6 | square kilometers | $km^2$ |
| | acres | 0.4 | hectares | ha |
| | | **MASS (WEIGHT)** | | |
| oz | ounces | 28 | grams | g |
| lb | pounds | 0.45 | kilograms | kg |
| | short tons (2000 lb) | 0.9 | tonnes | t |
| | | **VOLUME** | | |
| tsp | teaspoons | 5 | milliliters | ml |
| tbsp | tablespoons | 15 | milliliters | ml |
| fl oz | fluid ounces | 30 | milliliters | ml |
| c | cups | 0.24 | liters | l |
| pt | pints | 0.47 | liters | l |
| qt | quarts | 0.95 | liters | l |
| gal | gallons | 3.8 | liters | l |
| $ft^3$ | cubic feet | 0.03 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.76 | cubic meters | $m^3$ |
| | | **TEMPERATURE (EXACT)** | | |
| °F | Fahrenheit temperature | 5/9 (after subtracting 32) | Celsius temperature | °C |

*1 in = 2.54 (exactly).




## Approximate Conversions from Metric Measures

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| mm | millimeters | 0.04 | inches | in |
| cm | centimeters | 0.4 | inches | in |
| m | meters | 3.3 | feet | ft |
| m | meters | 1.1 | yards | yd |
| km | kilometers | 0.6 | miles | mi |
| | | **AREA** | | |
| $cm^2$ | square centimeters | 0.16 | square inches | $in^2$ |
| $m^2$ | square meters | 1.2 | square yards | $yd^2$ |
| $km^2$ | square kilometers | 0.4 | square miles | $mi^2$ |
| ha | hectares (10,000 $m^2$) | 2.5 | acres | |
| | | **MASS (WEIGHT)** | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.2 | pounds | lb |
| t | tonnes (1000 kg) | 1.1 | short tons | |
| | | **VOLUME** | | |
| ml | milliliters | 0.03 | fluid ounces | fl oz |
| l | liters | 0.125 | cups | c |
| l | liters | 2.1 | pints | pt |
| l | liters | 1.06 | quarts | qt |
| l | liters | 0.26 | gallons | gal |
| $m^3$ | cubic meters | 35 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.3 | cubic yards | $yd^3$ |
| | | **TEMPERATURE (EXACT)** | | |
| °C | Celsius temperature | 9/5 (then add 32) | Fahrenheit temperature | °F |



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# 1. OIS EXECUTIVE SUMMARY

The Operational Information System project is a proof of concept effort developed at the request of the Office of Command, Control, and Communications (G-T). In their Request for R&D Support, G-T directed the Research and Development Center to examine ways to improve the information flow in Coast Guard operations. The project examined information systems, using a business reengineering methodology in order to understand and improve the total work systems in field operations.

The Operational Information System core concept is to "Improve service to the maritime public by getting the right operational information to the right people at the right time to make the right decision." This implies a highly cross-functional system, covering most missions of the Coast Guard. OIS is a clear embodiment of the "One Port, One Command Center" principle espoused by former Commandant ADM J.W. Kime. It also supports the current Commandant's Eighth Strategic Goal, to "pursue and acquire new technologies that meet field commanders' needs and enhance mission performance."

## 1.1 PROBLEM STATEMENT

The problems described in this report have been identified by a variety of studies, both internal and external to the Coast Guard. The OIS testbed addressed only a selected subset of these problems, either in the technical high risk category or in the business process redesign category.

1. ***Redundant Data Entry.*** The Coast Guard's present-generation information systems are characterized by a great deal of redundant data entry.

2. ***Information not available to Field Personnel.*** Many current Coast Guard information systems are designed primarily to provide information to program managers. In several cases, this information is not available to field personnel later.

3. ***Inadequate Communications.*** The Coast Guard's existing communications systems are characterized by most studies as inadequate.

4. ***Inadequate Resource Picture.*** The resource picture is typified by command centers that have wall charts of their operating area with magnetic shapes of cutters, aircraft, and boats.

5. ***Cumbersome Tasking Process.*** Providing tasking to resources is frequently cumbersome in today's Coast Guard.

6. ***"Stovepipe" Information Systems.*** The Coast Guard's operating platforms and its personnel are multi-mission, but our information systems have not yet achieved that maturity. Instead, they are predominantly single-mission "stovepipes."

7. ***Proliferation of Systems.*** Because of the lack of cross-functional systems, Coast Guard command centers house an ever-increasing variety of information systems that do not communicate with one another.

8. ***Multi-level Security***. The Coast Guard arguably has a larger problem with *separation of* classified and unclassified information than any other agency.

## 1.2 OPERATIONAL INFORMATION SYSTEM GOALS

Analysis of the problem statements reveals that there are several common mission performance and workload impacts that result from these problems. The following three Operational Information System goals have been developed through analysis of the common elements impacting mission performance.

- ***Improve command and control*** *(problems 3,4,5,6,7,8).*
- ***Eliminate redundancy of reports*** *(problems 1,6,7).*
- ***Improve availability of information to field personnel*** *(problems 2,3,6,7,8).*

## 1.3 PROJECT APPROACH

The R&D Center split OIS into two phases, with the possibility of others in the future. Each phase began with a series of in-depth user workshops involving operational personnel from around the country. They focused on (a) defining information-related problems in current operations, (b) defining a set of solutions to those problems, and (c) describing the payoffs (benefits) anticipated. Based on the results of these workshops, the R&D Center developed proof-of-concept systems to evaluate the feasibility of implementing the ideas. The systems were installed in an actual operational environment for several months in order to validate and refine the functional requirements developed during the workshops, and subject the system *concepts* to the harsh light of real-world usage.

## 1.4 BENEFITS SUMMARY

Empirical data collected during the Group/Station OIS Testbed focused primarily on reports reduction. While there are measurable benefits from this feature, they are not large and are also not capturable. The consensus of the Group Commander and senior officers who visited was that the major benefits OIS could provide the Coast Guard are a result of improved resource utilization. Information would become a force multiplier, allowing better coordination of multi-unit operations. Operational commanders could leverage their assets to greater advantage, especially if OIS were combined with innovative crewing concepts such as the Norwegian Crewing Concept. This would enable business process reengineering such as more centralized command and control, and more centralized resource basing. The resulting organization would include less shoreside infrastructure, fewer coordination personnel. It would also enable covering the same areas with fewer assets.

## 1.5 CONCLUSIONS

It appears technically feasible for the Coast Guard to implement the Operational Information System. Most underlying technologies are well developed, with none posing unacceptable technical risk. The three highest risk technological areas in a full-scale deployment are distributed database technology, satellite communications, and pen-based computing. Further, information technology has matured to the point that the Coast Guard can now implement the Operational Information System cost-effectively.

The Operational Information System is a critical enabler for the One Port/One Command Center concept. In order to consolidate functions physically, they must be consolidated logically. If the Coast Guard simply houses the same business functions in a single room without changing their component work processes, the total workload will remain unchanged, and the same level of staff will be required to support them. OIS provides the cross-functional information infrastructure necessary to complete the logical consolidation.

OIS will increase operational commanders' span of control and act as a force multiplier, allowing the agency to perform assigned missions with fewer resources. This enables organizational flattening, with less District/Group Commands. Combining OIS with the introduction of improved boats and aircraft will enable the Coast Guard to operate with fewer resources in the field. This is an important enabler in meeting the Commandant's third strategic goal: "meet the mandate to streamline with no reduction in essential services."

Redundant data entry can be virtually eliminated. Automatic transfer of information from OIS to legacy systems such as SARMIS and LEIS II is a significant time saver, allowing greater focus on operations. This will also improve the work-life balance for Coast Guard people.

Embedding decision support functionality within OIS can improve the quality of decision making at all levels of the chain of command. It can also eliminate the need for extensive resident training on calculation and rule-based tasks. Training can focus on educating the person about the rationale behind performing tasks, but does not need to cover implementation details. This is especially valuable for tasks which are performed infrequently but are procedure-intensive. It also allows program managers to update policies and procedures easily by updating the decision support system.

OIS provides a tool for improved measurement of our operational services, and therefore better management of the resources. Capturing employment data as a byproduct of operations will increase accuracy and decrease workload.

## 1.6 RECOMMENDATIONS

Based on the results of the Group/Station Operational Information System Testbed, the Research and Development Center recommends the following.

That the Coast Guard undertake development of the Operational Information System. Appendix C contains a preliminary functional decomposition of the Phase I and II Research and Development testbed systems, which integrate Search and Rescue and Law Enforcement.

That the Coast Guard use the Operational Information System as a framework to integrate other major systems already in development. These include the Marine Safety Network and the Vessel Traffic System 2000. In addition to these major acquisitions, the Coast Guard has a substantial investment in the Navy's Joint Maritime Command Information System (JMCIS), or some of its variants. Both major cutters and major command centers ashore are currently users of these systems. This item will require that OIS exploit multi-level security technology.

That the Coast Guard implement the alternative in the Short Range Communications System proposals which includes the most capable data transfer capabilities, including secure data transmission.

That the Coast Guard implement a long range data communications system as part of an overall communications architecture designed to extend the existing shore-based wide area network to its operating resources.

That further research be done on human factors issues surrounding use of portable computers during boardings. The potential exists to improve the boarding process, but the results of the Group/Station Testbed were negative toward use of portable computers. This was clearly due in large part to technical flaws in the testbed system, but there remained a large unwillingness to commit to use of computers during boardings. The primary concern is that computers would require too much attention, detracting from the boarding party's situational awareness and safety. Unless further research indicates with a high degree of probability that design improvements can eliminate the concern about situational awareness, we recommend against implementation of portable computers during boardings.

# 2. INTRODUCTION

The Operational Information System project is a proof of concept effort developed at the request of the Office of Command, Control, and Communications (G-T). In their Request for R&D Support, G-T directed the Research and Development Center to examine ways to improve the information flow in Coast Guard operations. The project examined information systems, using a business reengineering methodology in order to understand and improve the total work systems in field operations.

The Operational Information System core concept is to "Improve service to the maritime public by getting the right operational information to the right people at the right time to make the right decision." This implies a highly cross-functional system, covering most missions of the Coast Guard. OIS is a clear embodiment of the "One Port, One Command Center" principle espoused by former Commandant ADM J.W. Kime. It also supports the current Commandant's Eighth Strategic Goal, to "pursue and acquire new technologies that meet field commanders' needs and enhance mission performance."

## 2.1 Problem Statement

The problems described in this report have been identified by a variety of studies. These include a GAO report of April 1990 entitled "COAST GUARD: Strategic Focus Needed to Improve Information Resources Management"; the Coast Guard's Strategic Information Resource Planning process (SIRMP); the Small Boat Station Staffing Study of July 1991; the Group Staffing Study of February 1991; and the Command Center Study of October 1991. The first five problems are stated in the form described by a group of field personnel during a series of intensive workshops (see Project Approach for details). The sixth is from the SIRMP process. The seventh is from the Command Center Study.

The OIS testbed addressed only a selected subset of these problems, either in the technical high risk category or in the business process redesign category. However, the OIS concept is to empower the Coast Guard's field personnel by solving each of these problems, or by integrating other Coast Guard systems that solve parts of them.

1. ***Redundant Data Entry.*** The Coast Guard's present-generation information systems are characterized by a great deal of redundant data entry. There are several layers to this problem. First, most systems support a single mission, and only a single aspect of that mission. Second, most systems do not support operations while they are in progress. Instead, they are primarily oriented to after-the-fact reporting for post-mission analysis. As a result, users frequently have to document a case in three stages, in three or more systems. They take handwritten notes during operations. They write record message Situation Reports, which are basically narrative summaries transcribed from their notes, at intervals of a few hours during operations. Finally, they enter summary information into various information systems after the operations are complete. The human watchstanders in command centers and aboard operating resources spend a substantial amount of their time ***processing*** information at a low level, such

as recording it and transcribing it. However, what they really need to do is ***analyze*** the information, and make decisions or take action based upon that analysis.

2. ***Information not available to Field Personnel.*** Many current Coast Guard information systems are designed primarily to provide information to program managers. In several cases, this information is not available to field personnel later. When it is available, the process for retrieving it is frequently so difficult that field personnel don't bother. Field personnel are doubly frustrated by this. They know that the information they are entering could be useful to them at a later date. But they also know that it will be difficult or impossible to retrieve it. Therefore, they have no incentive to make sure that it is accurate. They need the ability to easily retrieve information on operations previously conducted by their own units or others.

3. ***Inadequate Communications.*** The Coast Guard's existing communications systems are characterized by most users as inadequate. The communications system available to boats consists of VHF-FM voice radio on public frequencies, which covers the majority of the coastline. There is also a more limited-range "private" (DES encrypted to FOUO level) VHF-FM voice radio system, but there are much more substantial lapses in coverage. Very few locales have direction-finding capability. Data capability is extremely limited.

4. ***Inadequate Resource Picture.*** Command center personnel frequently do not have a current picture of all available resources and their status. The resource picture is typified by command centers that have wall charts of their operating area with magnetic shapes of cutters, aircraft, and boats. These shapes are moved at sporadic intervals by controllers after voice position reports from the operating units. If positions are not current when notification of a new case is received, critical time is spent updating the resource picture before selecting resources.

5. ***Cumbersome Tasking Process.*** Providing tasking to resources is frequently cumbersome in today's Coast Guard. Detailed search plans are relayed by voice communications systems, with humans reading and transcribing long strings of numbers. For larger units, they can be sent by record message, but the watchstanders at each end have to pick the points off the chart and type them into a record message, and invert that process at the receiving end. This process is error-prone and laborious.

6. ***"Stovepipe" Information Systems.*** The Coast Guard's operating platforms and its personnel are multi-mission, but our information systems have not yet achieved that maturity. Instead, they are predominantly single-mission "stovepipes."

7. ***Proliferation of Systems.*** Because of the lack of cross-functional systems, Coast Guard command centers house an ever-increasing variety of information systems that do not communicate with one another. Each has different user interface, training, hardware, and security requirements. Faced with a proliferation of systems, controllers frequently only know how to use portions of each. Further, when information must get from one to the other, the controllers wind up being the interface, reading from one system and retyping into the other. Systems present in many of the Coast Guard's District and Area Command Centers include the Coast Guard Standard Workstation for administrative use; a secure Coast Guard Standard Workstation for classified information processing; secure Navy Command and Control

systems for anti-drug network and other uses; a Coast Guard geographic display system for search planning and merchant vessel position tracking; Navy computers for Maritime Defense Zone functions; terminals for access into other federal agency systems such as the Treasury Enforcement Computer System; and terminals for access into state agency systems such as the National Law Enforcement Telecommunications System.

8. ***Multi-level Security***. The Coast Guard arguably has a larger problem with *separation of* classified and unclassified information than any other agency. Our multi-mission command centers and resources may find themselves handling an unclassified search and rescue or oil pollution case one minute, followed by a classified law Enforcement or National Security incident the next. Much of the information is common between the two, such as resource positions and capabilities. This makes it extremely important for the Coast Guard to develop a robust multi-level security capability within its command center information systems, to help authorized personnel integrate the classified and unclassified pictures while simultaneously prohibiting access by unauthorized personnel.

## 2.2 OPERATIONAL INFORMATION SYSTEM GOALS

Analysis of the problem statements reveals that there are several common mission performance and workload impacts that result from these problems. The following three Operational Information System goals have been developed through analysis of the common elements impacting mission performance. The following paragraphs provide detailed explanations of the linkage between each goal and the related problem statements.

- ***Improve command and control*** *(problems 3,4,5,6,7,8).*
- ***Eliminate redundancy of reports*** *(problems 1,6,7).*
- ***Improve availability of information to field personnel*** *(problems 2,3,6,7,8).*

Command and control is critically dependent on rapid, reliable communications (problem 3), with appropriate security in place (problem 8). These are needed in order to receive notification of situations which merit action; to monitor status of Coast Guard and other resources (problem 4); and to transmit action orders to resources (problem 5). Voice radio provided a huge advance in communications capability from the pre-radio era, but voice communications still require that a human act be directly involved in the act of communicating. Computer-to-computer communications eliminates that task. Further, system designers can not only have the computer perform the communications, but manipulate the data in order to present it to the user in a more readily understandable format. Command and control is inherently a time-critical task, in which seconds can make the difference in saving a life or intercepting a drug smuggler. The segregation of information into separate systems (problem 6) and the time required to retrieve it (problem 7) are time consuming elements in an environment which cannot afford extra time.

The Coast Guard has implemented numerous automated systems over the past decade in order to improve information availability. These systems have been sponsored by different program and support managers, however, and significant overlaps exist. This proliferation of independent systems (problems 6 and 7) has resulted in a substantial degree of redundancy in the information entered in each by the end user in the field (problem 1).

Many of the systems the Coast Guard has implemented are designed to provide information for headquarters use by program planners. Little information is available to field personnel, or the procedures for retrieving it are cumbersome (problem 2). Coast Guard field units are as a rule multi-mission, or cross-functional. However, information is fragmented among several systems (problem 6), and therefore field personnel must access, retrieve, and synthesize information from several sources in order to respond to an incident which crosses program boundaries. This requires significant training, effort, and precious time (problem 7). If some of the information is classified, a further impediment to rapid information retrieval is encountered (problem 8). The data communications infrastructure ashore is capable of providing improved access to information from many locations, but it must be expanded to incorporate afloat units.

## 2.3 RESEARCH OBJECTIVES

The R&D Center was tasked by the OIS Guidance Team to investigate critical portions of the OIS concept. These were:

- Develop a concept of operations for field operational information dissemination and gathering, and test technology and systems approaches that enable that concept.
- Support the Station Study Implementation Team and the Command Center Study Team in their efforts to improve the efficiency and effectiveness of Station and Group operations by providing information systems and technology that enable the improvement of the work methods and procedures.
- Further understand the operational information needs of Groups and Stations and the operational reporting needed to support Headquarters program managers and District operations personnel in order to maximize support for and minimize impact on field operations.

## 2.4 PROJECT APPROACH

The R&D Center has split OIS into two phases, with the possibility of others in the future. This was done to divide the problem into pieces of manageable size. Phase I dealt with Groups and Stations, and the Search and Rescue and Law Enforcement missions. Phase I is complete; this report is its final R&D milestone. Phase II deals with Districts, Air Stations and Groups. Like Phase I, it supports Search and Rescue and Law Enforcement.

Phase I began with a series of in-depth user workshops involving operational personnel from around the country. They focused on (a) defining information-related problems in current operations, (b) defining a set of solutions to those problems, and (c) describing the payoffs (benefits) anticipated.

Based on the results of these workshops, the R&D Center developed a proof-of-concept system to evaluate the feasibility of implementing the ideas. The Center proposed that the system be installed in an actual operational environment for several months. This testbed was to validate and refine the functional requirements developed during the workshops, and subject the system *concepts* to the harsh light of real-world usage. Therefore, the system had to be substantially

more robust than a typical proof-of-concept. At the same time, it was designed to achieve maximum demonstrated functionality with limited effort. Therefore, it is maintenance intensive. It is a throwaway, not suited for operational deployment.

The operational testbed was also restricted limited to working within the current business practice paradigm. G-NRS specified that the proof of concept effort include the technical system only, not incorporating any of the business changes which were suggested during the user workshops.

## 2.5 APPLICABLE DOCUMENTS

The following documents were used as references in designing and developing the testbed system, and during its evaluation:

1. Gru/Sta OIS *System Specification*, dated 16 November 1992.
2. Gru/Sta OIS *Data Model*, dated 26 March 1993.
3. Gru/Sta OIS *Software Unit Specification*, dated 23 July 1993.
4. Gru/Sta OIS *Problem Tracking System and Configuration Management Plan*, dated 22 November 1993.
5. GAO Report - April 1990, *Coast Guard Needs to Improve Strategic IRM Planning*.
6. GAO Report - May 1994, *Improving Mission Performance Through Strategic Information Management and Technology*.
7. DoD Instruction 5000.2, *Defense Acquisition Management Policies and Procedures*, February 23, 1991, Part 8, "Cost and Operational Effectiveness Analysis."
8. OMB Circular No. A-11, *Preparation and Submission of Budget Estimates*, July, 1992.
9. FIPS PUB 64, *Guidelines for Documentation of Computer Programs and Automated Data Systems for the Initiation Phase*.
10. LEIS II *Detailed Software Design Document*, dated 6 December 1991.
11. COMDTINST M5230.10A, *SARMIS Manual*, dated 10 January 1992
12. COMDTINST 3123.7J, *Abstract of Operations Reports*, dated September 1992.
13. COMDTINST M7110.1, *Benefit-Cost Analysis Manual for the Acquisition of Federal Information Processing (FIP) Resources* (Draft, 12/94).

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# 3. TESTBED DESCRIPTION

This section describes the physical and organizational environment in which the OIS concepts were evaluated. It also presents an abbreviated Functional Description of the OIS Phase I Testbed system. A more detailed functional description is in Appendix C.

## 3.1 OPERATIONAL DESCRIPTION

### 3.1.1 Group

Coast Guard Group/COTP Long Island Sound (GruLIS) is headquartered in New Haven, CT and covers Long Island Sound from the East River in New York to Block Island at the eastern end of the Sound. It includes three Stations, which are participants in the OIS testbed; it also includes an 82' WPB, a 65' WYTL, and an Aids to Navigation Team with 46' and 55' ANBs and several smaller boats. In addition to traditional Group duties, GruLIS is the Captain of the Port for both the area of responsibility described above and for the AOR of Group Moriches, encompassing the south shore of Long Island.

Group/COTP Long Island Sound is commanded by an O-6, with an O-4 Deputy and an O-3 Operations Officer. The command center is staffed by an Operations Duty Officer (QM1/BM1/QM2/BM2) standing 24-hour duty, and a Radioman of the Watch (RM2/3) standing 12-hour duty. During surge periods, an additional RMOW or ODO provide augmentation.

### 3.1.2 Stations

All three GruLIS Stations were part of the testbed.

Station Eatons Neck, NY is in Northport, NY, on the north shore of Long Island in western Long Island Sound. It is commanded by a Chief Warrant Officer (BOSN), and has a complement of 41 personnel, two 41' UTBs, and one 6.4m RHIB. Typical SAR case loading is from 900-1000 cases per year, with a significant percentage handled by Auxiliarists, commercial providers, and local agencies. The station typically conducts 200-300 ELT boardings per year.

Station New Haven, CT is in central Long Island Sound. It is commanded by a Chief Boatswain's Mate, and has a complement of 23 personnel, one 41' UTB, and one 6.4m RHIB. It also hosts an additional UTB, used as the Group spare. Typical SAR case loading is 300 cases per year, with the majority involving Station resources or Auxiliarists. Some responses involve commercial providers and local agencies. The station typically conducts 200 ELT boardings per year.

Station New London, CT is in the Thames River in eastern Long Island Sound. It is commanded by a Lieutenant, and has a complement of 43 personnel, two 41' UTBs, and one 6.4m RHIB. Typical SAR case loading is 400 cases per year, with about half involving Station resources or Auxiliarists. Responses involving commercial providers and local agencies are a smaller

proportion than at Eatons Neck but a larger proportion than at New Haven. The station typically conducts 600-700 ELT boardings per year.

### 3.1.3 Utility Boats

Prior to the OIS Testbed, all six GruLIS UTBs carried the standard UTB electronic outfit. The CG Headquarters SAR Facility Manager, G-NRS, granted permission to install a temporary nonstandard suite aboard these six boats for the duration of the testbed. In the course of the testbed installation, no standard equipment was removed or repositioned. The nonstandard equipment was added in a non-destructive fashion.

## 3.2 TESTBED FUNCTIONAL DESCRIPTION

The Functional Description presented in this Section is based on the Phase One R&D Testbed, as-built. Appendix C presents a Functional Decomposition of Phases I and II. A number of features from the complete system were not implemented in the testbed, or were only partially implemented, because of time and budget constraints. These include managing resources (the testbed allowed tracking of resource positions, but no capabilities descriptions, and no means of tracking dynamic operational commander relationships); interactive checklists; access to references; tools for resolving data conflicts; mechanisms for highlighting updates; and assigning tasking to resources. In general, the ability to access information in the database was limited to displaying the currently selected item only; there were no query and report tools allowing access to the entire database.

### 3.2.1 Data Model

The OIS logical data model was designed to support cross-functional integration of several legacy systems, thereby consolidating access to information and eliminating data entry redundancy (This eliminates redundancy from the user's perspective, by mapping between systems. From the system perspective, redundancy remains, and must be managed). The systems which were included in this integration are the Search and Rescue Management Information System (SARMIS); the Law Enforcement Information System II (LEIS II); the Abstract of Operations System (Aops); the Coast Guard Boarding Report (form CG-4100); SAR Situation Reports (SITREPs); and information required by current command center checklists and SOP during the course of case prosecution that does not feed these systems. This totaled some 600 attributes, which were organized into approximately 20 entities. The Phase I data model is available under separate cover. The design work in Phase II has extended this model.

The entire data model was implemented on the shoreside system. The mobile system did not include Abstract of Operations summary data, but provided the raw input for Aops; it supported all LEIS II and CG4100 data, and all but a few summary items from SARMIS.

### 3.2.2 Major Functional Areas

The major system functions are listed in Table 1. These represent the most significant ways in which the system must support users during operations. Italics indicate that a function was not implemented in the Phase I Testbed.

Table 1: Major OIS Phase I Functions (italics indicate items not implemented in testbed).

| Shoreside Subsystem | Utility Boat Subsystem |
|---|---|
| Geographic Information System (GIS) to integrate operational information | Electronic Chart System to improve navigational accuracy |
| Data entry, including source data capture (requires fast response for use during ops) | Source data capture, during SAR and boardings, via pen-based computer |
| Data distribution, allowing all units access to shared case information, including conflict resolution between updates. | Data distribution |
| *Electronic checklists* | *Electronic checklists* |
| Resource and facility tracking via GIS | Remote Dependent Surveillance System (RDSS) for ops and position reporting |
| Validation to verify completeness and accuracy for external system export. | *Validation* |
| Operational reports consolidation and export to external systems | Automatic Report Generation |
| *On-line access to LEIS II information* | *On-line access to LEIS II information* |
| *Electronic tasking to resources* | *Electronic tasking and status reporting* |
| *Integrated Decisions Aids, such as CASP and AMVER* | *Integrated Decisions Aids, such as regulation references on-line* |

### 3.2.3 Shoreside Subsystem

The Shoreside Systems at the Group and Stations are virtually identical. The only difference is that the Group system acts as the hub of a star network; the two Stations and six UTBs all communicate with one another via the Group. All other functional aspects of the Station systems are identical to the Group system.

The shoreside subsystem, depicted in Figure 1, runs on Hewlett-Packard Unix workstations, model HP-9000/750, procured via the US Navy Tactical Advanced Computer III (TAC-III) contract. The operating system is HP's version of Unix, HP-UX 8.07. The systems use the Navy's Unified Build (UB) Government Off the Shelf Software (GOTS) as a geographic display, but do not use the UB Track Database or Communications modules. (These UB modules do not support the data elements needed by the USCG systems to which OIS must export data). The OIS Shoreside System uses the Progress Relational Database Management System (RDBMS). Data stored in the RDBMS is displayed in a Graphical User Interface; the interface stores and retrieves data via Embedded Structured Query Language calls.

The Communications subsystem relies on the public-domain Kermit protocol for error detection and correction. It uses a COTS product called Secret Agent for DES-level data encryption, suitable for protecting information which is For Official Use Only (FOUO). There are three communications links: to other shoreside systems, to the mobile systems aboard utility boats, and to the CG Standard Workstation for legacy data export. For the testbed, all three links were implemented using serial communications. Shoreside communications were via dial-up modems and the public-switched telephone network. Communications between the boats and shore were via specialized dial-up modems (using the Microcom Networking Protocol 10, or MNP-10, for error detection and correction in the harsh Radio Frequency data environment) and the cellular phone system. Communications to the CGSW were via a terminal emulation session over a serial null-modem cable.

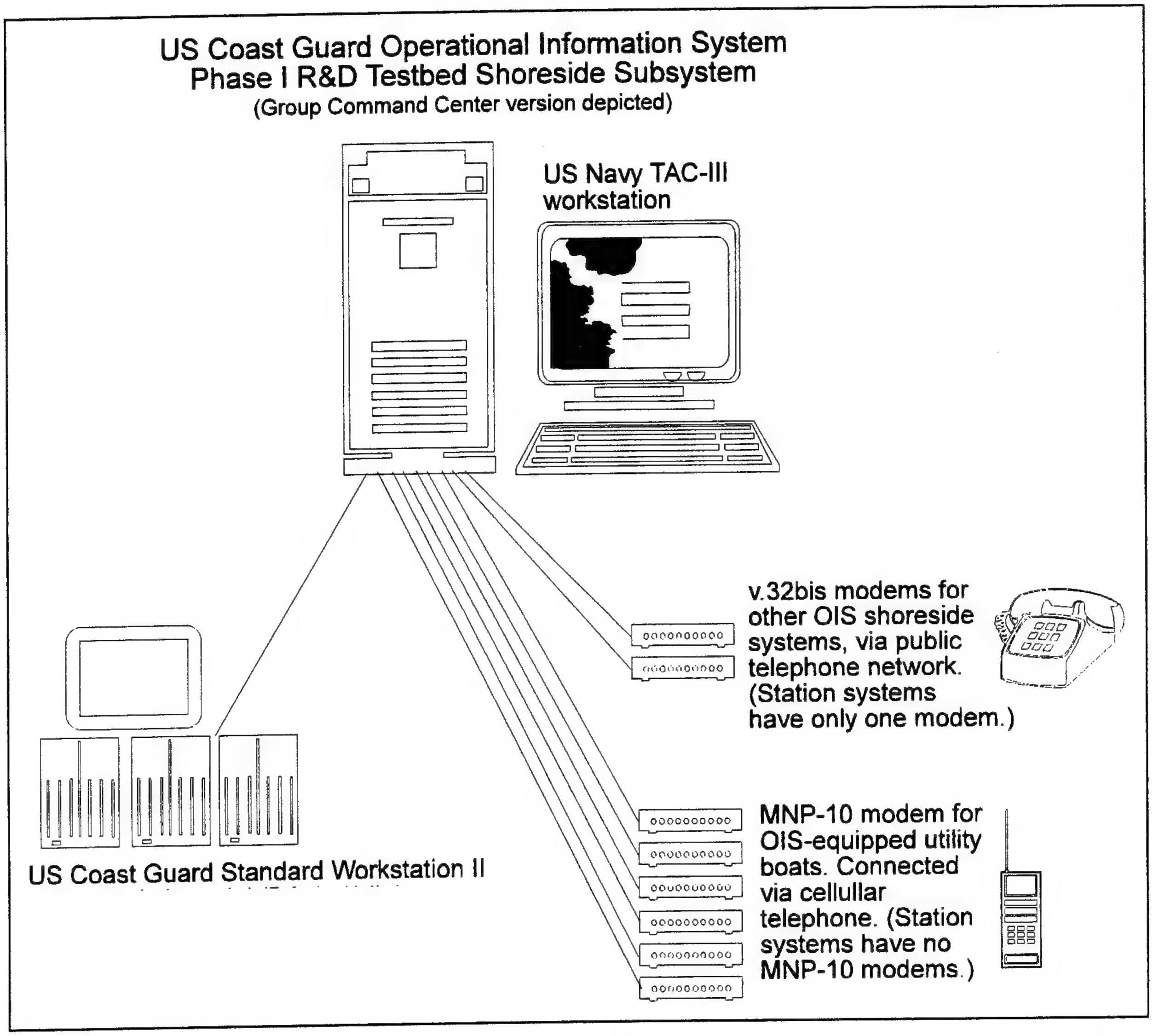


Figure 1: Shoreside Subsystem Schematic (Group version depicted)

From the user's point of view, the shoreside system was centered around a geographical information system capable of displaying any area in the world. It usually displayed the command center's Area of Responsibility, and the current position and status of all resources in the Group. Each operational incident in progress was represented by a floating Toolbar, with twelve buttons for displaying data about various aspects of the case. Clicking on any of the buttons accessed a set of screens with related data. In addition, each situation was represented on the geographic display by a symbol. The Toolbar buttons are:

- Situation Screen
- Sortie Screen
- Chrono Notes Screen
- Weather Screen
- Vessel Screen
- Person Screen
- Aircraft Screen
- Job Aids
- Data Conflict Review
- Transmit
- Validate
- Put Away

Two terms with explicit meaning to OIS are Situation and Resource Event. A Situation is similar to the typical concept of a Coast Guard "case," or operational response, and is defined as a multi-unit, multi-mission case. All information related to an operational response to a single incident is included as part of a Situation record, and is stored as such in the database and displayed as such in the user interface. A Resource Event is similar to the typical concept of a sortie. However, since definitions vary, an OIS Resource Event is defined as the time a single operational resource (which may be either Coast Guard or non-Coast Guard) is underway or airborne conducting the same primary mission (Abstract of Operations employment category) in response to the same Situation.

The Situation Screen gave users access to summary data about the case, including primary mission, incident type, key dates and times, Mission Coordinator, and units involved.

The Sortie Screen gave users a list of all Resource Events involved in the Situation. The data describing resource events includes dates and times underway, on scene, etc.; resource ID, primary mission and incident type; and sortie results and performance details. Each resource event also has associated with it a Job Aid, which is a replica of the checklist associated with that incident type.

The Chrono Notes Screen let users keep track of miscellaneous information received during a case, just as they do with current Chronological Logs. Chrono Notes from all units involved in the Situation are integrated into a single log.

The Weather Screen allowed users to describe observed weather at a specified location and time. The Phase I system did not support automated import of data from external sources such as National Weather Service.

The Vessel, Person, and Aircraft Screens each displayed a list of these entities involved in the Situation. The list of entities is presented in the upper portion of the screen, with the remainder used for data entry and update.

The Job Aids button displayed a list of SAR checklists. The checklists used for the Phase I testbed are taken from the First District Standard Operating Procedures (SOP). They consist of the checklist text displayed in a read-only screen. No data entry is possible, because the Phase I data model does not include tables for checklists. These checklists can be displayed on screen or printed, but not shared between sites.

The Data Conflicts button displayed a report of any conflicts encountered during the most recent transmission updating this case. Upon receipt of new data, each incoming data element was compared to its corresponding element in the local database. If they were different, the local database was not overwritten, and the incoming data element was displayed for the user to resolve the conflict. It displayed these as a text report which could be viewed on screen or printed. Users could read the conflict report, then navigate to the appropriate screens in order to update the fields in question. The shoreside did not implement any way of identifying which data in an incoming datagram was new. Since OIS transmitted the entire electronic case folder on each transmission, the user had no way to identify which information was new. The Phase I testbed system did not provide an easy-to-read case summary report. The only outputs available were a draft SITREP and a lengthy listing of the entire database contents.

The Transmit button controlled routing of OIS data. The first time a user clicked this button during a given Situation, the Transmit Control Window opens. This window presented a list of possible recipients for copies of this Situation. From then on, whenever the user clicked the Transmit button, the update was sent to all marked Recipients. The Phase I testbed system did not differentiate among recipients; all had full privileges to update data.

The Validate button initiated a check of the data in this Situation by the OIS Validation module. This feature examined the data from the Situation represented in the selected Toolbar for compliance with all requirements of the external systems. This check preceded all exports of data from the shoreside OIS system to existing Coast Guard information systems such as SARMIS, LEIS II and AOps. Missing data was flagged for the user to fill in. Upon successful Validation, the data could be exported to the Coast Guard Standard Workstations for insertion into the existing systems. (See the Reports Controller description).

The Put Away button dismissed the Toolbar for the selected Situation, removing it from the screen. The case data remained in the database unchanged, available for future editing. This simply cleared the screen.

In the Phase I testbed, the data model was built to allow most tables (entities) to be accessed independently of any particular Situation. However, the Phase I testbed did not implement

screens to allow cross-Situation access to these entities. For instance, the only way to find a vessel via the application screens is to know what Situation it was involved in, edit the Situation, then open the Vessel screen. The only query and report capabilities in the Phase I testbed are achieved using adhoc queries in SQL or 4GL. However, there is no underlying technical limitation preventing the implementation of user-friendly query screens allowing this type of cross-Situation access to vessels, people, weather, chronos, etc.

The Phase I shoreside system also allowed users to enter non-Coast Guard resource information in a category called "Excoms." These are non-mobile resources, such as marinas, hospitals, fire departments, and police departments. The name Excom is taken from the National SAR Manual's term for Extended Communications Search, since these facilities are often called during an Excom. However, a more generic name, such as facilities, would be less restrictive and more suitable in the future. Phase I includes a single database table called Excom which allows unlimited total records, with one record for each facility to be described. The fields include latitude, longitude, phone number, point of contact, an icon code, and Excom name. Each Excom is represented on the electronic chart by an icon.

### 3.2.4 Utility Boat Subsystem

The Utility Boat subsystem consisted of several interconnected hardware platforms, as depicted in Figure 2. Most user interaction was with a portable pen-based computer. The testbed used an IBM PC-compatible computer manufactured by Telepad Corporation and based on the Intel 80386SL CPU operating at 25 MHz. This machine weighed 3.5 pounds, and allowed data entry either by a traditional keyboard (detachable) or by writing and tapping an electronic pen directly on the screen. The computer could be carried like a clipboard and powered by batteries for up to 2.5 hours. This computer hosted the mobile part of the "electronic case folder," and was designed to be carried by Coast Guard boarding officers during law enforcement boardings. A lightweight printer was used to print out receipts for the boater. The Telepad ran Microsoft Corp's "Windows for Pen Computing" operating system, version 1.0. This is based on Microsoft Windows 3.1, with extensions to support handwriting recognition.

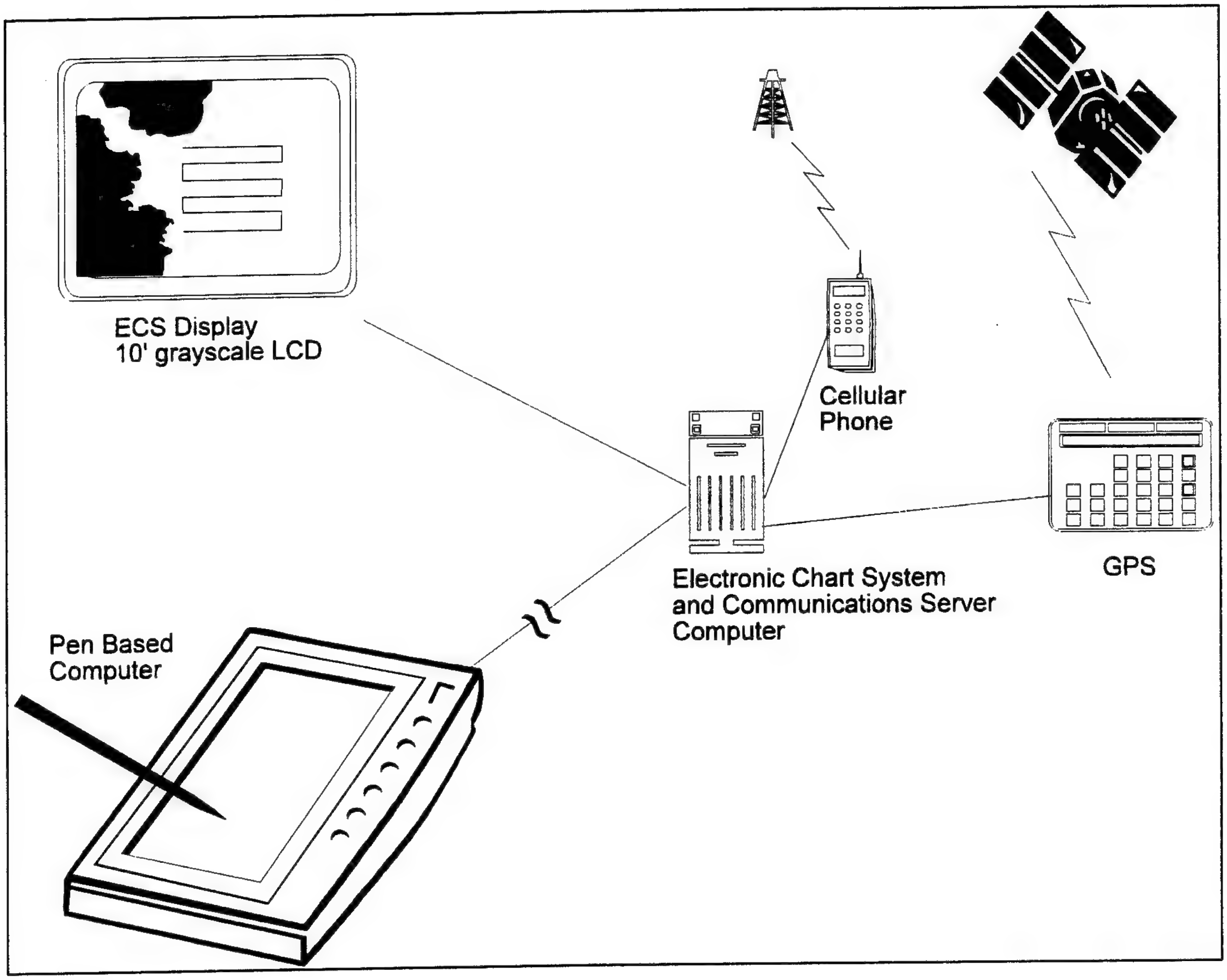


Figure 2: Utility Boat subsystem schematic.

The other major component of the boat subsystem was an IBM-PC compatible computer mounted permanently aboard the UTB. This machine acted as a communications server, and also ran a COTS Electronic Chart System (ECS) software package. The ECS received position information from a Differential Global Positioning System (dGPS) receiver, and displayed the UTB's current position on an electronic chart. The communications server buffered messages between the shoreside system and the pen-based computer. The computer was highly ruggedized, and enclosed in a watertight housing. It used an 80486-compatible CPU from Cyrix corporation. The communications to shore were handled by a Microcom modem using the MNP-10 error detection and correction protocol, which is optimized for cellular telephony. The COTS ECS software package was MapTech Corp's "Pilot" software. Pilot is MapTech's low-end ECS package, providing basic ECS functionality: current position display; 20 waypoint route planning; navigation error indicators; alarms; and track logging. These functions are with the standard for Electronic Chart Systems (but not for the more-capable Electronic Chart *Display Information* Systems, ECDIS). In addition to providing own-ship navigation, this computer forwarded the boat's position to the shoreside system with each user-requested transmission, and automatically

every fifteen minutes. OIS thus provided Remote Dependent Surveillance System (RDSS) capability.

The OIS mobile application which ran on the pen-based computers provided data entry screens for a subset of the data in the shoreside system. The items not supported on the mobile application are primarily those which are related to end-of-quarter Abstract of Operations processing. The design goal was to maximize similarity between the mobile application and the shoreside application, in order to minimize cross-training requirements. The screens were not exactly the same, however, for two reasons. First, the screen size of 10" diagonal measure limited the number of data elements that could be grouped on an individual screen, especially for fields that required handwriting-optimized screen elements, which are larger. Second, the mobile application supported fewer data elements, described above.

During Law Enforcement boardings, the boarding officer used the pen-based computer to capture all data about the boarding to support both the Boarding Report, form CG-4100, and the Law Enforcement Information System II (LEIS II). The boater received a printed report about the size of a cash register receipt, 2.25 inches wide and 8 to 10 inches long. Back aboard the USCG utility boat, the pen-based computer was connected to the Communications Server computer by an RS-232 serial cable. The communications server received the data from the pen-based computer using the Ymodem protocol for error detection and correction. The communications server then encrypted the data using Secret Agent, and forwarded it to the Group's shoreside system using the MNP-10 protocol for error detection and correction. The Group system automatically routed data to the parent OPFAC of the transmitting utility boat, so that it was available at the Station.

During SAR cases, the mobile application was designed to allow the boat crew to either actively enter data, or simply receive it from shore. When data was received from shore, however, there was not a report capability which showed the entire case summary in one screen. Rather, the user had to navigate through the various screens to retrieve case facts. The mobile application was not built around an RDBMS, like the shoreside. Instead, it relied on flat files for data storage. The implementation of the flat file storage did not provide a data conflict handling mechanism. There was no mechanism for the pen-based system to automatically alert the user that files were waiting on the communications server computer. Users had to be notified by voice radio from shore when new data was sent, then change screens, and tap a button to tell the communications server to send files it had received from shore to the pen-based system.

The boat's current position could be sent from the ECS computer to the pen-based system on request, by changing to the Transmit screen and tapping a button.

At the start of a new Situation, if two different units began collecting data at the same time, they were actually creating two different Situations (the database key fields are assigned automatically at Notification time). The Phase I Testbed did not implement a capability to merge Situations.

### 3.2.5 System Security

OIS is an unclassified system. Some of the information handled (Law Enforcement tasking and boarding reports) is For Official Use Only. Other parts (any information about people) are Privacy Act sensitive.

During the Phase I Testbed, OIS shoreside systems were installed in areas with physical security in the form of controlled access. These were Group and Station Operation Centers and Communication Centers. Group Long Island Sound has undergone formal certification of its spaces, and the Stations had not.

OIS Shoreside systems required a username and password for any access. OIS mobile systems implemented a login screen offering username and password control, but its use was discontinued because of difficulties with entering a password with the electronic pen. Users could not tell when characters were misrecognized by the system, and so had difficulty gaining authorized access. Future versions will need an improved method of access control beyond standard password schemes.

All OIS communications were protected by DES encryption. This encryption was implemented in software, using a COTS encryption package called Secret Agent, by Information Security Corporation. OIS created a separate file for each transmission. These were encrypted using Secret Agent's public key/private key scheme. El Gamal key management is built into Secret Agent, eliminating the need to manually distribute key material.

Privacy Act constraints that apply to LEIS II were adopted for OIS. Specifically, LEIS II does not provide a capability to search its Sighting and Boarding Histories for information on specific people. For instance, there are no standard queries that allow you to ask "which boardings has John Doe, SSN 123456789, been involved in?" However, LEIS II does support person queries in its Lookout database. Similarly, the Phase I Testbed does not support such queries, and developers of future versions will need to do research on the Privacy Act implications before implementing such queries.

# 4. DATA COLLECTION AND EVALUATION PLAN

This section describes the approach for assessing the value of OIS to the Coast Guard. The approach includes both objective and subjective measures of functions incorporated into the Phase I Testbed system, and calculated (theoretical) measures for items that were not included in the Testbed system but are part of the target system.

The evaluation tools used include: time studies, with both self-logging and third party observers; questionnaires; user interviews; workshops; the technical team's Problem Tracking System for system problems; User Comments entered directly into the system; and impromptu meetings between support personnel and users during the course of providing training and technical support.

## 4.1 Hypotheses

The evaluation approach began with the development of a set of hypotheses regarding the expected benefits of OIS. These are derived from the Problem Statements and Research Objectives in Section I, and form the foundation for this evaluation. The hypotheses are:

A. OIS will reduce data entry and report preparation time.

B. OIS will increase accuracy and completeness of reports.

C. OIS will improve command and control ($C^2$) by reducing $C^2$ response time.

D. OIS will improve navigational accuracy of standard boats.

E. OIS will provide better on-scene information to field personnel.

## 4.2 Objective Metrics

The evaluation team defined 18 metrics as candidates for objective measurement during the Group/Station OIS Testbed in Group Long Island Sound. Of these, eight were selected for use. The choices were based on (1) feasibility of data collection, and (2) whether or not the item to be measured was included in the Phase I Testbed system, and therefore available for measurement. Each was described in detail on data collection worksheets for the field users. These are displayed in Appendix B.

Baseline data were collected for several of these metrics. The evaluation plan called for two measurements, one early in the testbed and another two to three months later, to measure the effects of training and hands-on use. However, because of the time required for technical support of the testbed system, only one round of measurement was achieved, late in the testbed. Pre-OIS baseline data were collected in Group Moriches, New York (on the south shore of Long Island). Analysis of historical SARMIS and SEER data, and discussion with CGD1(osr) and (ole) staff indicated that the activity levels were similar enough that the comparison would be valid.

For statistical reliability, it was found necessary to collect a minimum of 20 samples in support of each individually numbered metric; 30 samples were recommended. The basis for this determination was an assumption (later proven true via baseline data collection) that 90% of SARMIS reports take between six and twenty minutes to complete. This gives a mean of thirteen minutes and a standard deviation of 4.24 minutes. Sample size was estimated by two different techniques: (1) a *t*-test, with an expected pre- and post-OIS mean difference of 3 minutes, and two-tailed alpha-level of .05; and (2) an estimate based on a moderate effect size (percent variance accounted for equal to 25%), two-tailed alpha-level of .05, and power equal to .95. A sample size of 20 is sufficient for both these conditions. SEER times were estimated to be similar for the purposes of the sample size calculation.

All 18 candidate metrics and the hypotheses they support are listed below. The ones selected for measurement are italicized. Metrics 1 and 2 are similar to metrics 8-11; the difference is that 1&2 apply to field personnel (boat crews), while 8-11 apply to command center personnel (OODs, RMOWs, watchstanders).

**A. OIS will reduce data entry and report preparation time.**

1. *Time to enter data in the field*
2. *Time to transcribe data in the field*
3. *Time to prepare reports*
4. Time spent on adhoc (on-request) reports
5. Amount of overtime

**B. OIS will increase accuracy and completeness of reports.**

6. Number of errors detected in manual case reviews
7. *Number of required and optional fields missing from reports*

**C. OIS will improve command and control by reducing $C^2$ response time.**

8. *Time to record data (at initial distress call)*
9. *Time to transcribe data into OIS*
10. *Time to identify resources*
11. *Time to dispatch*

**D. OIS will improve navigational accuracy of standard boats.**

12. Search pattern execution accuracy

**E. OIS will provide better on-scene information to field personnel.**

13. Number of effective LE boardings
14. Number of LEIS violations overturned
15. Number of recreational boating safety violations
16. Number of manuals accessed on board
17. Number of queries to LEIS II
18. Avoid doing the wrong boardings

### 4.2.1 Issues Regarding Measurement

The OIS testbed began in the late spring, as Group Long Island Sound was entering its peak operational season. Typically, when people are under time pressure, they prefer to do things in a familiar way. Therefore, they would be less apt to spend the time to learn a new system, even if

there are long-term savings associated with using the new system. In order to get a useful evaluation of OIS, it was deemed imperative to provide group and station personnel with as much up-front training and familiarization as possible. This was done via a training ramp-up schedule which started several months before the testbed system was actually installed.

Another concern had to do with having the group and station personnel log the times required for certain activities. A part of this concern was that we may be overtaxing an already-busy group of people. A related concern was that busy people may opt *not* to record the data (either not record it at all or give guesstimates), which would reduce the accuracy of our data. Also, since these personnel are often involved in multiple cases simultaneously, it might be impossible for them to give good estimates of how much time they spent on any given case. For example, they might start to transcribe data into OIS and be interrupted by a phone call. Minutes, or even hours, might elapse before they return to the transcription task. In this case, it would be very difficult to estimate how much time the transcription took. Because of this, the data may be very messy, and only very large effects of OIS might become apparent. (This concern was in fact borne out. The discussion in Section 4 regarding Hypotheses A and C contains details.)

#### 4.2.2 Analysis Plan

Pre-and post-OIS time study data were compared. If the mean time to perform a task using OIS is less than the mean time to perform that task using pre-OIS methods, and the difference is determined to be statistically significant, the hypothesis is considered valid to a stated degree of confidence. The degree of confidence were tested using Student's t-test. This test assumes that the time data are distributed normally.

The following specific comparisons were made, supporting the indicated metric:

1. ***Time to enter data in the field:*** The time required by field personnel (boat crews) to capture data *the first time* using pre-OIS methods (paper and pencil) were compared to the time required after OIS is installed. If a post-OIS user captures data using paper and pencil, that is what was measured here; time to transcribe it into OIS is addressed in metric 2. (It was not expected that there would be significant SAR-related data entry by field personnel, either pre- or post-OIS. Case documentation is almost entirely maintained ashore in current practice. Metrics 1 and 2 were be used to assess whether OIS changed this paradigm.) The raw data were captured by an observer using the data collection sheets in Appendix B.
2. ***Time to transcribe data in the field:*** The time required by field personnel (boat crews) to transcribe data *after its initial capture* using pre-OIS methods (paper and pencil) was compared to the time required after OIS is installed. If a post-OIS user captures data using paper and pencil, the time measured here represents time spent entering it into the OIS screens from the hand-written notes. Pre-OIS transcription is counted as time spent copying notes from scrap paper into the official chrono log or case folder, even if this happens after the boat crew returns to base. The raw data were captured by an observer using the data collection sheets in Appendix B.

3. ***Time to prepare reports:*** The time to complete a SARMIS report was compared to the time required to validate a SAR case using OIS. The time to complete a SEER report after each boarding was compared to the time to validate the boarding information using Operational Information System. The raw data were captured by user self-logging using the data collection sheets in Appendix B.
7. ***Number of required and optional fields missing from reports:*** A random sample of 20 case folders were selected from a unit's SAR case files. Each folder was reviewed to determine whether any data elements were missing. If any were missing, they were noted. The total number of missing fields were normalized the entire sample.
8. ***Time to record data (at initial distress call):*** The time required by command center personnel to capture data *the first time* using pre-OIS methods (paper and pencil) was compared to the time required after OIS is installed. If a post-OIS user captures data using paper and pencil, that is what was measured here; time to transcribe it into OIS is addressed in metric 9. The raw data were captured by an observer using the data collection sheets in Appendix B.
9. ***Time to transcribe data into OIS:*** The time required by command center personnel to transcribe data *after its initial capture* using pre-OIS methods (paper and pencil) was compared to the time required after OIS is installed. If a post-OIS user captures data using paper and pencil, the time measured here represents time spent entering it into the OIS screens from the hand-written notes. Pre-OIS transcription is counted as time spent copying notes from scrap paper into the official chrono log or case folder. The raw data were captured by an observer using the data collection sheets in Appendix B.
10. ***Time to identify resources:*** The time required to choose and assign the SRU for a SAR case was measured, pre- and post-OIS. This time includes total person-minutes expended by command center personnel in trying to locate SRUs, ascertain current operational status, and decide which to assign. The raw data were captured by an observer using the data collection sheets in Appendix B.
11. ***Time to dispatch:*** The time required to draft tasking orders and relay them to the resource was measured, pre- and post-OIS. This time includes total person-minutes expended by command center personnel in creating an action plan or search plan, checking it, picking search area descriptors off the chart, drafting the action message, and communicating the data to the resource. It does not include time spent aboard the resource in receiving and interpreting the plan. The raw data were captured by an observer using the data collection sheets in Appendix B.

### 4.2.3 Experiment Design

The next three subsections describe the experiments which were designed to test these hypotheses and metrics. The results and analyses are presented in Section 4, Research Results. Complete raw data are presented in Appendix A.

#### *4.2.3.1 Experiment 1: Time Study*

This experiment was designed to test hypotheses A and C, metrics 1,2,8,9,10, and 11. The goal of the time study was to understand the amount of time operational personnel spend handling various types of information during operations, broken down into the six categories described in the individual metrics.

***Control Group:*** Observers were assigned to the command center at each unit involved in the testbed, and to both boat crews at each station. The observation was conducted on two busy summer weekends. Observers were posted in shifts, so that operational personnel were observed from 0800 until 2359 both Saturday and Sunday; basically, the plan called for a "saturation study" during a typical busy summer weekend, during which approximately 50-60 single-unit SAR cases could be expected. Each observer was instructed to watch for information handling activities. For each information transaction, the observer was to measure the time spent handling that transaction, the originator and the recipient, and the nature of the transaction. If the nature was SAR or LE, the observer was also to record the case number. All operating units in the testbed had simultaneous coverage. The time study was scheduled to be conducted once pre-OIS, and again post-OIS.

As a backup to direct observation, system users were asked to answer a questionnaire assessing whether OIS helped them handle information more easily during operations. The questionnaire responses are discussed in the subjective metrics section.

***Test Group:*** The same group of observers were assigned to conduct the same study after OIS had been in use for about two months. This length of time was chosen in order to allow OIS user familiarity to stabilize before conducting the post-OIS measures.

#### *4.2.3.2 Experiment 2: Report Preparation Time*

This experiment was designed to test Hypothesis A, metric 3.

***Control Group:*** Users of the existing Search and Rescue Management Information System / Data Entry System (SARMIS/DES) system were asked to record time required to enter SARMIS/DES data for each SAR case during spring and summer 1994. This represented the baseline data for comparison with OIS. SARMIS/DES data entry is performed after the case is complete. The information has previously been entered by hand into paper case folders and checklists. The baseline group also recorded the time required to report law enforcement information using the existing SEER system. This information is reported after the boarding is complete, and is transcribed from the Boarding Form (Boardings), or from some form of local log (Sightings).

***Test Group:*** Users of the OIS testbed system were asked to record time required to ***validate*** SAR cases entered into OIS. OIS encourages users to enter data as it becomes available during a case. Further, it analyzes the "case folder" and provides a report describing which information is necessary to complete the documentation. The time required to record data during the case could not be measured (experiment 1). The important difference between pre-OIS and post-OIS

methods, however, is how much time OIS saves in after-the-case documentation. This is ***validation time***, and is directly comparable to the SARMIS data entry time. OIS users were also asked to record ***validation time*** for LE Boardings. The data were entered into OIS using the pen-based computer, then transferred to the shoreside system. In a fashion similar to SARMIS, the LE validation time is compared to total SEER time.

***Test Group Modification:*** The Test Group sample size for SARMIS data was not sufficient for statistical significance (see Research Results section for details). Therefore, the following controlled experiment was designed to simulate the actual test group conditions as closely as possible. Two non-rated personnel from a Station which had been involved in the testbed were selected to participate in the test. They were chosen because they had been assigned as communications watchstanders during the testbed, and were therefore typical users of the shoreside system. 49 SAR cases were chosen at random from OIS for them to re-validate. The cases were actual ones which had been prosecuted and entered into OIS during the testbed. They were "de-validated" by the tester, by deleting 40 data elements from each case. Data elements deleted were typical of those which would not normally be populated at the end of the case.

#### *4.2.3.3 Experiment 3: Report Completeness*

This experiment was designed to test Hypothesis C, using metric 7.

***Control Group:*** The comparison standard for this experiment is a completely populated case folder. This includes all information required in distress checkoff sheets, case folders, chronological logs, SITREPs, SARMIS, and incident checklists.

***Test Group:*** Twenty traditional SAR case folders (paper files, not OIS) were selected from a Station's files at random. All information in each of these case folders was reviewed by a team of field personnel who were experienced in case prosecution and documentation. They determined which data was required for proper documentation of each incident type, and then whether or not it was present. After this analysis was complete, they transcribed into the OIS Shoreside System and ran the Validation module.

## 4.3 SUBJECTIVE METRICS

Many OIS benefits are intangibles, and do not lend themselves well to quantitative measures. These were addressed in user questionnaires, interviews, workshops, the Problem Tracking System, User Comments, and impromptu meetings between support personnel and users during the course of providing training and technical support.

The first of these methods, questionnaires, allows assessment of the strength of a group's opinions by ranking scales. To gather these data, four separate questionnaires were designed, targeted at the following classes of user:

- Command Center personnel
- Operational reporting personnel
- Coxswains

- Boarding Officers

### 4.3.1 Analysis Plan

The questionnaire responses were tallied, and frequency distributions of the responses prepared. These frequency distributions indicated positive or negative user opinion about certain features, and the strengths of those opinions. Users were also asked to offer comments about each question. Analysts used these opinions to assess technical adequacy of the testbed system, and as a framework for crafting follow-up questions.

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# 5. RESEARCH RESULTS

The hypotheses are restated below in bold print. The metrics selected for evaluation are included.

**A. OIS will reduce data entry and report preparation time.**

*1. Time to enter data in the field*

*2. Time to transcribe data in the field*

*3. Time to prepare reports*

**B. OIS will increase accuracy and completeness of reports.**

*7. Number of required and optional fields missing from reports*

**C. OIS will improve command and control by reducing $C^2$ response time.**

*8. Time to record data (at initial distress call)*

*9. Time to transcribe data into OIS*

*10. Time to identify resources*

*11. Time to dispatch*

**D. OIS will improve navigational accuracy of standard boats.**

**E. OIS will provide better on-scene information to field personnel.**

From the proof of concept perspective, the OIS Phase I project was an unqualified success. Opportunities for improved effectiveness were revealed in many diverse areas. Users testified to the potential of OIS in relation to their daily duties, and Commanding Officers attested to its potential for dramatic effectiveness improvements and positive impact on the operations of their units. This consensus was tempered, as expected, by the use of the word "potential." There were significant technical and implementation problems in the testbed which must be resolved before moving forward with the concept. Without exception, these were related to the nature of prototyping, in which time and money limit the robustness of the project. The OIS Phase I testbed did not reveal any conceptual problems.

The hypothesis that OIS would decrease workload associated with operational reporting was proven with extremely high levels of statistical significance. During the OIS Phase One Testbed, the source data capture for SAR cases on the shoreside systems resulted in over 60% time savings associated with SARMIS and SEER report preparation. User suggestions and technical team redesign lessons during the testbed could reduce that figure even further. The results strongly suggest that nearly all current operational reporting could be eliminated, replaced by a short period of review at the end of each case.

The hypothesis that OIS would increase completeness of operational reports was also proven. The amount of data that was missing from manually prepared case folders was a surprise to everyone involved. The ability to improve completeness is especially important *during* operations.

The hypothesis that OIS would improve command and control ($C^2$) was not proven during the OIS Phase One Testbed. However, users responded uniformly in interviews and workshops that the failure to improve $C^2$ was a result of implementation flaws, both in features not implemented and in software bugs. The most significant $C^2$ features lacking were (a) the ability to display meaningful reports, including case summaries and new data summaries, both ashore and afloat; (b)

the ability for the user to easily reconcile conflicts between data held locally and data received from other units; and (c) the frequent failures in communication (over 10%), which destroyed user confidence.

The hypothesis that OIS would improve the navigational accuracy of standard boats was strongly supported by the subjective metrics, including questionnaires and interviews. Users unanimously endorsed the idea of using electronic chart systems to improve navigational accuracy and reduce risk of grounding in small boat operations. They had only one basic concern, which was policy-related: *"What happens if I run aground using the ECS and I don't have a paper plot?"* This question stems from the fact that this was a proof of concept. It can be answered by issuing a policy statement in advance of deployment.

The hypothesis that OIS would improve availability of information to field personnel was not proven. The lack of meaningful reports cited in the $C^2$ section above was the major factor in users' dissatisfaction with the on-scene information provided. Further, there was no capability for two-way query and response against the LEIS II database, which was one of the primary types of information users wanted access to.

The remainder of this section presents a more in-depth discussion of the research results. Complete raw results can be found in Appendix A.

## 5.1 Objective Metrics

This section presents the experiment results. Benefits they point to are discussed in the Benefits Analysis section.

### 5.1.1 Experiment Results

#### *5.1.1.1 Experiment 1: Time Study*

##### *5.1.1.1.1 Experiment 1 Results*

The data collected in the pre-OIS observation weekend varied very widely, with average transaction times reported fluctuating from seconds to minutes. The consensus of the observers was that even with the high observation coverage achieved, the resulting data were suspect. They reported that the granularity of the information being handled was too fine for them to accurately record the details required. Put differently, the average transaction time is short, and the transaction volume is high. Because of these limitations, the evaluation team concluded it was infeasible to achieve a statistically valid comparison between pre- and post-OIS times. The post-OIS observation was therefore canceled.

##### *5.1.1.1.2 Experiment 1 Analysis*

Interviews with command center personnel and the Group Commander indicate that the time spent on information handling during operations is high. There is a significant amount of redundant briefing, wherein a command center watchstander relays the same information by voice

circuits to several different units. This occurs both down the chain of command, to resources being tasked, and up the chain, in providing briefings both inside the unit and in parent commands. If the briefing information were available from OIS, it would free up a significant amount of watchstander time. The value of the time freed up in this manner is potentially enormous, since any delay in relaying information during a case can significantly impact actions taken by resources. This can make the difference between success or failure of the case.

#### *5.1.1.2 Experiment 2: Report Preparation Time*

##### *5.1.1.2.1 Experiment 2 Results*

In the group providing baseline data collection, 282 samples were taken involving SAR cases (SARMIS/DES) and 52 involving boardings (52 boardings reported in 26 SEER messages). During the OIS testbed, 31 samples involving Law Enforcement boardings were collected, which was found to be an adequate sample size. However, only 11 samples were taken involving SAR cases, which was an insufficient sample size for achieving statistical significance. Therefore, a controlled experiment was designed.

Two non-rated personnel from a Station which had been involved in the testbed were selected to participate in the test. They were chosen because they had been assigned as communications watchstanders during the testbed, and were therefore typical users of the shoreside system. 49 SAR cases were chosen at random from OIS for them to re-validate. The cases were actual ones which had been prosecuted and entered into OIS during the testbed. They were "de-validated" by the tester, by deleting 40 data elements from each case. Data elements deleted were typical of those which would not normally be populated at the end of the case.

For LE data, OIS reduced data entry time from an average of 12.2 minutes per boarding to an average of 5.1 minutes per boarding, a savings of 7.1 minutes. For SAR data, OIS reduced data entry time from an average of 11.7 minutes per SAR case to an average of 4.5 minutes per SAR case, a savings of 7.2 minutes.

##### *5.1.1.2.2 Experiment 2 Analysis*

The results of experiment 2 indicate that OIS saved a significant percentage of user time by eliminating the requirement to manually enter the data in other systems after operations. Table 2 and Table 3 summarize the results of the report time study, including sample sizes, means, and standard deviations. A t-test was applied, and found that the results are statistically significant. The strength of association is high.

The results of this experiment indicate a substantial time savings would accrue to the Coast Guard as a result of implementing OIS. For every Search and Rescue case, SARMIS requires a Unit Report. The results in Table 2 indicate a savings of 7.2 minutes, or 62%, each time a Unit Report is filed. Similarly, Table 3 indicates a savings of 7.1 minutes, or 58%, in documenting each LE Boarding compared to using the SEER system. Both savings are substantial, and were achieved with a proof of concept system, not a fully-featured system. Numerous suggestions for

improvement were received from field users, which would enable even more substantial improvements..

Table 2: Statistical comparison of SAR info reporting time, pre- and post-OIS. Data indicate time in minutes.

| Unit | Pre-OIS SAR Case Count | Pre-OIS SAR Case Mean Time | Pre-OIS SAR Case Time SD | Post-OIS SAR Case Count | Post-OIS SAR Case Mean Time | Post-OIS SAR Case Time SD |
|---|---|---|---|---|---|---|
| **1** | 6 | 10.0 | 0.0 | - | - | - |
| **2** | 242 | 11.6 | 2.3 | - | - | - |
| **3** | 10 | 16.0 | 4.4 | - | - | - |
| **4** | 24 | 10.7 | 1.5 | - | - | - |
| **5** | - | - | - | 49 | 4.5 | 1.8 |
| **ALL** | **282** | **11.7** | **2.4** | **49** | **4.5** | **1.8** |

Table 3: Statistical comparison of LE info reporting time, pre- and post-OIS. Data indicate time in minutes.

| | Pre-OIS | | | | | | Post-OIS | | |
|---|---|---|---|---|---|---|---|---|---|
| Unit | SEER Msg Count | Boarding Count | SEER Msg Mean Time | Boardings per SEER | Mean SEER Time per Boarding | Boarding Time SD | Boarding Count | Boarding Mean Time | Boarding Time SD |
| **1** | 5 | 8 | 21.4 | 1.6 | 13.4 | - | - | - | - |
| **2** | 11 | 22 | 23.3 | 2.0 | 11.6 | - | - | - | - |
| **3** | 10 | 22 | 24.1 | 2.2 | 11.0 | - | - | - | - |
| **4** | - | - | - | - | - | - | 31 | 5.1 | 2.7 |
| **All** | **26** | **52** | **23.2** | **2.0** | **12.2** | **5.7** | **31** | **5.1** | **2.7** |

### *5.1.1.3 Experiment 3: Report Completeness*

#### *5.1.1.3.1 Experiment 3 Results*

The testers analyzed each of 20 paper SAR case folders selected at random to determine which data elements were missing. Of the 20 case folders sampled, 10 were incomplete. 68 total data elements were missing. On average, for cases that were missing data, 6.8 data elements were missing. For the total population of cases, an average of 3.4 data elements were missing.

A typical SARMIS entry consists of about 60 mandatory data elements, and another 30-50 which are optional or may be required depending on the nature of the incident. The detailed results may be found in Appendix A.

#### *5.1.1.3.2 Experiment 3 Analysis*

A chi-square test was applied, and found $\chi^2$=485, df=1, and p<$10^{-100}$. This indicates a strong likelihood that a high percentage of case folders in the Coast Guard are incomplete.

The business value to the Coast Guard of missing data in typical case folders is normally not high; however, in certain instances it would be critical. For instance, in any case where lives were lost or property was damaged, incomplete data could jeopardize the Coast Guard's success in a court case. In such cases, personnel are likely to take more care to ensure quality documentation. However, countering these efforts is the fact that these cases are by their nature more complex, so the potential for missing information is substantially higher.

The most vital cause for concern is not that data may be missing at case conclusion, however, but that information received by one Coast Guard member during the case may not be recorded and shared with all others involved in the case. This lack of information could substantially change the nature of the response, and therefore affect the results of the search. The OIS distributed database approach minimizes the chances of such an omission, by ensuring that all parties have access to the critical information while the case is in progress.

This experiment only examined completeness of case data, not accuracy. Accuracy is addressed in the surveys.

## 5.2 Subjective Metrics

This section analyzes the surveys completed by users near the conclusion of the OIS Phase I testbed, as well as the subsequent interviews and workshop results. The results indicate a strong consensus that the OIS concept is sound, and will be valuable to users once the system is fully developed. They also clearly indicate that the technical deficiencies and features not implemented in the Phase I testbed system were strong negative motivates for users. This paradoxical situation is best embodied in an analogy by the Group Commander: "The wheel is round. We had a number of flat tires along the way, but the value of the concepts was clear throughout."

### 5.2.1 Analysis of Command and Control Survey Responses

As a general rule, the Group Command Center Controllers rarely used OIS. While this was a major disappointment, the reason is found in the fact that the testbed system did not provide them with any additional capability. The classic command and control cycle is to receive information, analyze it, decide, and act. Unreliable OIS communications reduced the reliability of the "receive" aspect of the cycle to about 90%, and the system did not provide feedback regarding success or failure of communications. The testbed also did not provide adequate tools to support the "analyze" aspect of the cycle and, in fact, added confusion because new and old case information was not distinguished. Finally, the OIS testbed did not provide a means to communicate an action plan or to issue a tasking to operational resources. In conclusion, the OIS proof-of-concept failed to adequately support nearly all of the Group Command Center Controller requirements.

Despite the shortcomings cited above, the Phase One testbed did provide substantial $C^2$ benefits in certain areas. During one major search involving all six Group UTBs over several days, the Group Commander was able to watch the search unfold on the screen in the command center by simply walking in and observing. He did not have to disturb the command center watch, which was immersed in handling the case. Most significantly, he saved a resource and eliminated an

information choke point by choosing not to deploy an on scene commander (OSC). Normally, in such a search he would have deployed CGC BOLLARD, a 65 foot icebreaking tug, to that role.

The automated communications in OIS, had they been reliable, would have provided tremendous value to command center personnel. This benefit grows exponentially as each additional unit or resource is added to a case, since the command center watch is the information broker for a mission. If they have tools that improve the quality and speed of information dissemination during a multi-unit case, they can spend more time planning the response and less time communicating those plans.

Despite the problems stemming from the implementation flaws, interviews with the Group Commander, Operations Officer, and Senior Duty Officer revealed tremendous confidence that the command and control functionality would provide substantial process improvements. In fact, the Group Commander felt that it would enable a centralized dispatch operational paradigm, in which the Group watchstanders handled all cases throughout the group. This would lower workload on the stations and eliminate another layer of information flow during operations, creating further process improvements. He sees this concept as a critical enabler for successful employment of the Norwegian Crewing Concept.

To summarize the Group Commander's assessment of the command and control benefits: the geographical plot afforded him a situational awareness of operations not previously available. The geographic display provided an overview of the entire AOR with tools for determining ranges, bearings, locations, and other vital operational information. In addition to having a display of all landmasses and fixed assets, he and his Operations Duty Officers could track operational resource locations effortlessly by monitoring their automatic position reports display on the electronic chart. He could exercise command and control of a case far more effectively than with grease pencil renderings. The automated generation of draft SITREPs reduced the amount of time that operational personnel had to spend on during-the-case reporting of case information. The database of unit case information would have been extremely powerful had it provided solid queries and reports to give him access to the information.

### 5.2.2 Analysis of Operational Reporting Survey Responses

The Operational Reporting Surveys indicated that although the Phase One system saved time in documenting cases, it still had room for improvement. Perhaps the biggest complaint was that OIS "required too much data." In point of fact, the converse was true: the Validation feature ensured that OIS only *required* the bare minimum of data. However, the elegance of that feature was lost on users who had to navigate through several screens in order to enter missing data. OIS offered a large number of optional data elements, but ones which may at times be required by external systems so had to be available. These were not required by OIS in most instances, but their very presence in the data entry screens caused user perceptions of too many required entries.

Follow-on interviews with users yielded the concept of "smart checklists," which should improve on that situation dramatically. The checklists envisioned would be based on those used in command centers, and would be the primary data entry interface with OIS. One scrollable window would incorporate critical elements of location information, vessel description, person

information, and sortie dispatch and tasking. It would also allow users to select any individual entry and generate a corresponding chrono log entry, complete with their user ID and the time. The system would store the data from these checklists in the appropriate database tables, but the user would not have to navigate through multiple screens. Checklists would contain only the vital information, not the "nice-to-have" pieces of additional information, so the system would appear simpler. But the user would retain the option of adding greater detail by going to the vessel screen, for instance, to enter or read discretionary information.

The second most common complaint was that OIS required users to "make up" responses. This complaint stemmed almost entirely from two data elements which were implemented poorly in the Phase One system: Person date of birth, and Reason Search Suspended. Both of these were required by the Validation routine in a substantial number of cases, and caused strong negative perception. The design which called for them to be implemented in this fashion was short-sighted. Person date of birth, for instance, was mandatory as a means of differentiating between people who may be share the same name. However, the Privacy Act implications for OIS indicate that it will be unlikely for users to have query and reporting capability on people across multiple cases, this is unnecessary. Designers can simply assign unique numbers to each person within the same situation.

### 5.2.3 Analysis of On-Scene Information Survey Responses

The survey responses regarding on-scene information were strongly negative. Most typical was the user who said, 'Why use a computer? I can talk faster than I can type!" But these responses uniformly focused on outgoing communications, which implies data entry. The Phase One mobile system did not provide any query or reporting capability whatsoever; if a user wanted to find out case status, s/he had to navigate through the data entry screens to locate the desired information. This, coupled with the lack of reliability in OIS Phase I communications, meant that OIS did not support their information needs well. However, when analysts described possibilities for improved reliability and reports, users felt that it would be valuable.

It is clear that a data system will not replace voice communications completely. However, several users envisioned being able to rely on voice communications for the important task of *exception reporting*, or discussing only those aspects of the case which seem anomalistic. By adopting this paradigm, voice communication requirements placed on the boat coxswain could be greatly reduced. This would remove the time dependency which requires that the shore watchstander and a boat crewmember both be available for a conversation at the same instant. Thus, it would allow the coxswain to review the information when it is operationally safe and convenient, and avoid being interrupted during critical evolutions by voice radio calls. It would also relieve the coxswain of the need to visit the operations center to gather mission information before getting underway, which would be a significant time-saver at a vital juncture early in the case.

Finally, secure data transmission provides for the most "silent" means of coordinating operations available. The existing voice circuits are protected at the DES level, but listeners can still tell that a transmission is occurring, and the direction from which it is coming. Data is transmitted in bursts, much more rapidly than voice; it typically took less than five seconds to transmit an entire Situation record in the Phase One testbed.

### 5.2.4 Analysis of Pen-Based Computer Survey Responses

Survey responses strongly indicated dislike for the pen-based computer. There were several significant shortcomings of the pen-based computer equipment, and of the mobile application software, which account for a large portion of the disfavor. These are:

- The pen-based computer was far too slow. It took 11 seconds to load the vessel or person screens. This seemed like an eternity to users; some estimated it at over a minute.
- The computer was not rugged enough, nor waterproof. All six survived their eight months in the field, but only by being "babied." Field personnel expect their equipment to stand up to the harsh environment in which they work. Portable computers will need to be capable of withstanding repeated drops from at least four feet, and must feel solid enough that users believe that they can. They must also be completely waterproof, but yet provide easy access to connectors when needed.
- The computer's battery life was deemed unsatisfactory. Actually, battery life was over two hours when users paid careful attention to keeping batteries charged and avoiding the effects of battery "memory" common to Nickel Cadmium rechargeables. This is something users shouldn't have to pay attention to, however. Longer life, easy charging aboard the boat, batteries which don't exhibit memory effect, and easy-to-read indicators of battery status are all critical to successful use of portable battery-powered devices.
- Users reported data loss on a handful of occasions. This completely eliminated trust.
- The mobile software forced users to save their work manually, instead of saving it automatically like the shore system.
- The mobile software required users to perform several steps to transmit and receive data, and did not notify users when new data was received.
- The mobile software did not provide any reports. The only way to find case information was to navigate through the screens.
- The mobile software forced users to change screens several times to enter the data required for a typical boarding. This, coupled with the computer's slow response, made them feel very awkward at certain points during a boarding.

#### *5.2.4.1 Impacts on Situational Awareness*

Clearly there are more than enough deficiencies here to explain user dissatisfaction. However, when questioned during interviews and in workshops, most users said that even if all these problems were solved, they were still reluctant to espouse the concept of using a pen-based computer during a boarding. These users felt that even if the bugs were worked out, they would be more comfortable remaining with paper, and entering a report later. A much smaller group of users felt that using a pen-based computer would be a significant improvement to the boarding process, because of the potential for speed increases and decreased workload. Interestingly, both sides of this debate were concerned primarily with Boarding Officer safety. The next two paragraphs summarize their key points.

Over 80% of Phase One users felt uncomfortable with the pen-based computer, as evidenced by the numerous suggestions that the screens should be made to look just like a 4100 form. They reported that they had to focus more attention on the computer than on paper 4100 forms. This contributed to a feeling of tunnel vision, or a decrease in situational awareness. Also, it took five to ten minutes longer to do a boarding using the pen-based computer than with paper, even after users had conducted a number of boardings. Although this was due to the deficiencies mentioned earlier, it was clearly unsatisfactory.

A few users did feel comfortable with the pen-based computer, despite the testbed system deficiencies. They reported that because of the easy-to-use picklists, they could work just as easily as with paper. However, even in this group, none reported being able to work faster than with paper. There were a large number of user suggestions and technical evaluation points which would improve the speed of the computer application substantially, almost certainly making the process faster than with paper. These users pointed out that with innovative use of the technology, the process could be speeded up tremendously. Consider retail cash registers: by scanning bar coded information from products, stores have eliminated errors and cut time. This could be done with driver's licenses and vessel registrations, leaving little to enter except violation data.

If there is less data to enter, it would seem to follow that situational awareness should improve. However, human perceptions of computers rarely follow logic so simply. The amount of dissatisfaction introduced by the deficiencies listed above made it impossible to isolate the variable which was of primary concern, the effect on situational awareness. It appears that there is strong potential for process improvement, and we recommend that the Coast Guard do further human factors testing using a technically improved mobile platform. However, based solely on the results of the Phase One testbed, it would clearly not be prudent to implement use of pen-based computers Coast Guard-wide for data capture during boardings.

#### *5.2.4.2 Other impacts of pen-based computer use*

##### *5.2.4.2.1 Decision Support*

The Phase One testbed included a small Decision Support (DSS) module, designed to test the concept of DSS for field computer users. By tapping a button, users could obtain detailed reference information about recreational boating safety (RBS) equipment requirements depending on boat size and type. This module was developed as a Cadet project at the Coast Guard Academy, and was not integrated into the rest of the pen-based system for the testbed. However, user trials of the DSS module were conducted separately. Their response was generally favorable. The testbed system implementation was too slow and needed user interface enhancements, but showed promise.

Embedding decision support in the portable computer is the factor that will make it worth pursuing. If the portable computer provides source data capture only, it is an expensive, fragile clipboard. However, if it is used to provide information on demand, references, and other support that enhances the boarding officer's job performance, it will be well worth it. The most promising area for development is providing regulation references and enforcement assistance. For instance,

fisheries regulations are very volatile, changing frequently throughout the year as stock sizes are re-measured and quotas re-allocated. Distributing this information electronically and having a powerful search engine for accessing the regulation of choice would be a quantum leap forward in the ability of our boarding officers to enforce these complex regulations. Commercial Fishing Vessel Safety, Immigration laws, and Zero Tolerance procedures are all examples of regulatory areas in which field personnel could use improved information tools. This would raise the level of performance across the board. By providing this information in easily accessible and updatable form, policy-makers can also improve the timeliness of policy updates.

Computer based training is closely related to this topic. By embedding training modules into the system, program managers can provide high quality recurrent training without the high cost of either bringing people into a resident school environment or providing touring experts to the field.

#### *5.2.4.2.2 Functional Design*

The mobile system software was purposefully designed to closely mirror the shoreside system software. It offered all the cross-functionality of the shoreside system, and the screens were similar. The design philosophy at work was to push the envelope of cross-functionality, and have all components of OIS be as thoroughly cross-functional as possible. However, while this concept works well in a command center environment where the mission at hand can change in an instant, it was not as well-suited for mobile use. The pen-based computer was used almost exclusively during boardings, so the SAR portions of the application were rarely used. They were, however, frequently maligned as adding unnecessary complexity. Further, the small screen size and slow processing speed of the pen-based computer made it less well-suited for a cross-functional application with a wide variety of data elements.

Future versions of portable computer software should be optimized for individual tasks, not for a range of tasks. However, the pen-based computer could remain as the platform that would host multiple different job-specific mobile applications: a boarding officer module, a SAR SRU module, etc. could all be available on the pen-based computer, and could share data. They would simply provide different function-based sequences and methods for entering and retrieving data. This is conceptually similar to the need for interactive checklists described in the Command Center analysis.

### 5.2.5 Extensions beyond SAR and Law Enforcement

Group Long Island Sound is also a Captain of the Port (COTP). The chief of port operations was very interested in the possibility of using OIS to support his missions. Even though the Phase One project did not include direct support for port operations in its database schema, he envisioned taking the pen-based computer out with crews deployed in either a truck or a boat, to provide better communications and source data capture in chrono notes for automated POLREP generation. This highlights the fact that operational scenarios where Coast Guard personnel are deployed to perform mobile field operations supported by remote command and control are common to all Coast Guard Operational Programs. Portable computers would be highly useful in oil spill and hazardous materials incident response, commercial vessel inspection, casualty investigation, port operations, refugee operations, and others.

# 6. BENEFITS ANALYSIS: OIS PHASE I

The major benefits which OIS can provide to the Coast Guard lie in its ability to enable business process reengineering, and leverage our assets to greater advantage for mission performance and service to the American public. The Group/Station OIS Testbed was constrained to working within the existing organizational structure, and so did not yield any empirical data defining the extent of the reengineering possibilities. But interviews conducted with the Group Commander and his Operations staff during the Testbed revealed high confidence that the Operational Information System could allow significant improvement. Several flag officers who visited the testbed similarly indicated support for the potential of OIS. Briefings invariably moved rapidly from the testbed system as built to the possibilities presented by a widely deployed, robust system. The Commandant and Chief of Staff reportedly share their high levels of interest.

The cross-functionality inherent in the Operational Information System is consistent with the farthest-reaching recommendations of the Coast Guard's Strategic Information Resource Planning process, or SIRMP. It would improve utilization of Information Technology resources, by sharing information and costs between programs, providing direct support for the Commandant's eighth strategic goal, to "pursue and acquire new technologies that meet field commanders' needs and enhance mission performance." It is a natural fit with the flag-level study teams currently exploring ways to streamline Coast Guard operations and the training system. These teams have the challenge of supporting the Commandant's third strategic goal, to meet the mandate to streamline with no reduction in essential services. OIS would play a key role in enabling these visions.

The Group/Station OIS Testbed emphasized operational reporting. The results showed that report consolidation and elimination would save field personnel valuable time, with benefits totaling roughly a million dollars per year fully deployed. However, this offsets only a portion of the total cost of OIS, and would not warrant further development on its own merits. Further, the benefits of report reduction are not capturable in the budget, because the average benefit was on the order of one tenth of an FTE per unit. Another significant OIS benefit results from an improvement in search effectiveness. This is achieved by coupling improved search precision of individual SRUs with improved search planning. Yet another benefit, and the only one of these three which is a direct cost avoidance, is a decrease in damage from small boat groundings because of improved navigation provided by the Electronic Chart Systems. This is typical of the benefits OIS offers to the Coast Guard. Efficiency gains within the existing organizational structure would be valuable, and effectiveness gains could be substantial. But if the Coast Guard deploys OIS within the existing organization, there will be few direct cost savings or avoidances, and benefits will not offset system costs. OIS both enables business process reengineering, and requires it in order for the agency to realize the full potential benefits.

This chapter begins with a more detailed discussion of the ways in which OIS would provide these opportunities for reengineering. It then presents further details of the benefits measured during the Group/Station Testbed, and summarized in the previous paragraph.

## 6.1 Command and Control Improvements

By providing a platform to integrate several systems already in place and initiatives already underway, OIS could enable the Coast Guard to improve business processes, perform assigned missions with fewer resources, streamline the organization, and decrease our shoreside infrastructure. The situation today is not unlike the move from visual communications (or none) to voice radio. By equipping vessels with radios, the Coast Guard was able to coordinate them effectively for the first time, shifting from a large number of independent resources to a smaller number of coordinated resources, the sum of which was more effective. OIS is the key to taking the next step, enabling the Coast Guard to coordinate multi-unit operations even more effectively.

The last two decades have seen steady increases in the frequency of coordinated multi-unit operations, especially in the law enforcement and marine environmental protection mission areas. The task of actually coordinating these operations is difficult and frequently ineffective. Communications are cited as problem areas in nearly every study of operations. The nature of voice communications is a major part of this problem. If a voice circuit fails to connect or is noisy, the field user must either go without communications or expend considerable effort to get a small amount of information through. If a data circuit fails to connect, on the other hand, the computer carries out the retries to ensure delivery.

Newly available technologies and public data communication services allow the same amount of information to be transmitted in data form much faster and more reliably than by voice. For instance, an OIS Phase I datagram representing the entire case folder consisted of about 1,000 bytes (characters) of information, and could be transmitted in less than five seconds. This same information would take several minutes to transmit by voice. Because of the time savings, the transmission will be significantly less expensive on a usage-sensitive circuit.

Replacing voice communications with data provides another substantial improvement in operational coordination. Because of the computer processing power on either end, data can be converted into information for the user, enabling quicker and better analysis of the updates. This information can be used by the recipient at the recipient's own convenience, instead of when the originator is available. This is an important enhancement for both effectiveness and safety. Helicopter pilots involved in the Phase II user workshops placed a very high value on this feature of data communications, since they allow the pilots to conduct sensitive evolutions such as a hoist or hover without being interrupted by a voice radio call. Personnel aboard mobile resources would now be able to view information when they are ready for it, not when it is forced upon them by an external source.

Remote dependent surveillance system (RDSS), or resource tracking, provides another significant command and control improvement. The operational commander can literally watch an evolution unfold on the screen in the command center. This eliminates the need to call units for frequent updates, which require the simultaneous attention of personnel onboard the mobile resources and in the command center. Most significantly, it can actually save dedicating a resource to serve solely as On Scene Commander. The resource that was used for that duty can be dedicated strictly to searching, or can be kept in port, ready for another mission. In the case of sustained coordinated operations, such as the Commander Task Unit (CTU) missions being performed in

several Districts, the OSC or CTU would continue to be used, but would have much better control of geographically dispersed units.

It is clear that a data system cannot replace voice communications completely. However, OIS would provide operational personnel the opportunity to rely on voice communications for the important task of *exception reporting*, or discussing only those aspects of the case which seem anomalistic.

Finally, secure data transmission provides for the most "silent" means of coordinating operations available. The existing voice circuits are protected at the DES level, but listeners can still tell that a transmission is occurring, and the direction from which it is coming. Data is transmitted in bursts, much more rapidly than voice; these bursts are harder to detect than steady voice transmissions.

## 6.2 Business Process Reengineering

The combination of these improvements can have dramatic effects for the Coast Guard. The Group Commander in the Phase One Testbed felt that by combining OIS and the Norwegian Crewing Concept, he could easily handle the existing workload with five Utility Boats instead of the six currently assigned to the Group. They could be based in one or two locations in Long Island Sound instead of three, and be much more flexibly staged for scheduled events. Group command center watchstanders would handle all cases throughout the group. Personnel reductions would be possible, both in communications watchstanders and support personnel. Shoreside infrastructure would be reduced.

There are obviously many details that must be worked out if such an arrangement is to be pursued. But the key is that it is now clearly feasible, through a combination of OIS, innovative resource crewing concepts, and other concepts that have been discussed during the recent streamlining and training infrastructure studies.

## 6.3 Decision Support

Embedding Decision Support Systems (DSS) in OIS computers will make a large improvement in operational performance. The computers at each location can provide information on demand, references, and recommendations. These systems can be updated more easily and quickly than policy updates distributed on paper, and less expensively. When a user is involved in an unusual incident, the reference is more readily available, and can be searched for exact details.

An important part of the benefit of DSS is its ability to provide the user with "just-in-time" information. This reduces the need to store infrequently used information in the user's brain, in the same way that just-in-time manufacturing reduces a company's need to store parts in warehouses. Information is available to the user in an easily retrievable format when it is needed. An example of this potential occurred during the training period just before the beginning of the Group/Station Testbed. A UTB crew discovered a small amount of marijuana during a boarding, and conducted a Zero Tolerance seizure. There are well-defined policies governing this type of

seizure, but few are conducted, so users were not immediately familiar with the necessary steps. Shoreside personnel spent a substantial amount of time hunting down references. They envisioned the boarding officer being able to access the references and detailed step-by-step guidelines right on the portable computer, and transmit updates to the shoreside command center easily.

## 6.4 REDUCED TRAINING REQUIREMENTS

In addition to the improvements described in the previous section, DSS could provide dramatic reductions in training requirements. The Training Infrastructure Study Team is examining ways in which the training system can be overhauled to provide better quality training at lower cost. Computer-based training (CBT) embedded within the Operational Information System will support this effort, allowing training to be provided to a larger number of personnel at lower cost. There are two primary mechanisms at work here. First, we could eliminate training on tasks which are calculation-intensive. Let the computer do the calculations, and *educate* the human on how to interpret and apply the results. Second, we could dramatically reduce training on lengthy rule-based tasks. In both cases, the machine can manipulate information and present it in a manner suitable for making the critical decisions.

Eliminating training on these rote tasks could cut the course schedule substantially. However, this should not be interpreted to mean that DSS can eliminate the entire time allotted to these activities. It is still important to educate the person about the meaning of the tasks, the underlying concepts, and how they relate to the overall framework of the job being performed. As an example, including DSS and CBT for search planning functions could enable the SAR School to eliminate over a week of training from their schedule, and focus the remaining time even better on education of the students about the concepts.

CBT can also prepare students for resident schools before they arrive, covering prerequisite material so that they are more ready to learn upon arrival. For instance, a boarding officer module could teach boating safety regulations, licensing and documentation requirements, and actual use of the form, so that students arrive at MLE School ready for education about the concepts of jurisdiction, officer safety and presence, and self-protection. CBT and DSS embedded in OIS could reduce resident training requirements, a major benefit to the units, the training budget, and the Coast Guard's "General Detail" or personnel over-allocated for training purposes.

## 6.5 BENEFITS QUANTIFIED DURING GROUP/STATION TESTBED

The remainder of this chapter quantifies some of the benefits attributable to Coast Guard-wide deployment of the Operational Information System, Phase I. Table 4 lists the major features included, and is the basis for this benefits analysis.

The primary functional difference between Phase I and Phase II of the OIS R&D projects is the additional integration of Computer Aided Search Planning System (CASP) in the shoreside system. The primary resource difference is the addition of Cutters, Aircraft, District and Area

command centers. This would involve developing an additional mobile subsystem, optimized for aircraft use. Cutters would use a system based on the ones in shoreside command centers.

Table 4: Major OIS Phase I functions.

| Shoreside Subsystem | Utility Boat Subsystem |
|---|---|
| Geographic Information System (GIS) to integrate operational information | Electronic Chart System to improve navigational accuracy |
| Data entry, including source data capture (requires fast response for use during ops) | Source data capture, during SAR and boardings, via pen-based computer |
| Data distribution, allowing all units access to shared case information, and resolving conflicts between updates | Data distribution |
| Electronic checklists | Electronic checklists |
| Resource and facility tracking via GIS | Remote Dependent Surveillance System (RDSS) for ops and position reporting |
| Validation to verify completeness and accuracy for external system export. | Validation |
| Operational reports consolidation and export to external systems | Automatic Report Generation |
| On-line access to LEIS II information | On-line access to LEIS II information |
| Electronic tasking to resources | Electronic tasking and status reporting |
| Integrated Decisions Aids | Integrated Decisions Aids, such as regulation references on-line |

Table 5 summarizes the annual and life cycle benefits attributable to the Operational Information System, Phase I. Each line item in the benefit summary is discussed in detail in a section of this chapter. The first set of benefits are those which are directly quantifiable, ***and*** capturable within the Coast Guard budget as either direct cost savings or cost avoidances. The second set of benefits are quantified, but cannot be captured within the Coast Guard budget. For instance, reports reduction will save our field personnel from working overtime. However, since military personnel are not compensated for overtime work, this does not present a benefit that can be captured in the budget. It is likely to produce long-term benefits such as better retention because of improved working conditions, reduced health care cost because of lowered stress, and similar work-life concerns.

Table 5: OIS Phase I benefit summary.

| Benefit Type | Benefit Description | One-Time Benefit ($M) | Annual Benefit ($M) | Total Life Cycle Benefit ($M) |
|---|---|---|---|---|
| Monetizable Benefits (Direct Cost Avoidance or Savings) | | | | |
| | Avoidance of accidental collisions and groundings | | $2.0 | $20.0 |
| | **Subtotal, Monetizable Benefits ($M)** | **$0.0** | **$2.0** | **$20.0** |
| Non-Monetizable Benefits (Indirect Cost Avoidance or Benefits to Society in General) | | | | |
| | Report Reduction | | $0.6 | $6.3 |
| | Improved Search Accuracy | | $2.2 | $21.6 |
| | **Subtotal, Non-Monetizable Benefits ($M)** | **$0.0** | **$2.8** | **$27.9** |
| **Total Benefits ($M)** | | **$0.0** | **$4.8** | **$47.9** |

### 6.5.1 Reduced Groundings Through Navigational Improvements

The Electronic Chart System used aboard Utility Boats in the Phase I Testbed was a solid success with users, and provides clear financial benefits in direct cost avoidance of groundings due to (a) navigation error or (b) high coxswain job tasking preventing sufficient time to navigate manually.

Coast Guard small boats operate with crews of three or four personnel. They operate nearly exclusively in coastal and piloting waters, with high mission tasking nearly every time they get underway. Although the coxswain's primary responsibility is the safety of the boat and crew, the high mission tasking frequently prevents formal fixes; the coxswain estimates position by seaman's eye between fixes, while all other hands are performing an evolution for which s/he is the leader.

In this environment, the Coast Guard small boat sometimes runs aground, suffering varying damages. G-N-1 estimated that total small boat grounding damages over a five year period ending in 1992 were $38 million, or about $8M per year. Coxswains and Officers in Charge during the Phase I Testbed estimated that over 50% of groundings could be avoided by use of Electronic Chart Systems. That equates to a direct cost avoidance of over $4M per year. Since the estimate is based on subjective analysis, not empirical data, it is discounted by half for the benefit calculation below. Even conservatively, this OIS benefit would save some $2M per year, as shown in Table 6.

Table 6: Annual benefit from reduced groundings, Phase I.

| | |
|---|---|
| Annual damages resulting from groundings | $8,000,000 |
| Estimated reduction in grounding rate resulting from ECS use | 25% |
| **Estimated Annual Benefit** | **$2,000,000** |

There is another direct benefit to using Electronic Chart System aboard boats. Currently, the coxswain spends a substantial amount of time performing the task of plotting navigational fixes, as high as 50%. Electronic Chart Systems will return almost all of that time to the coxswain, by enabling the coxswain to focus on analyzing the boat's position and situation as presented on screen, rather than plotting it. This time can be used either for improved crew management or for analyzing the external environment. In the aviation world, this is referred to as "head outside the cockpit" time, and refers to the need to avoid focusing attention on the instruments and other equipment inside the cockpit. The same principle applies to coxswains.

### 6.5.2 Reports Reduction

Reports reduction was one of the primary objectives of the Phase I Testbed. The Small Boat Station Staffing Study, the OIS user workshops, and numerous other studies have all indicated that this is an area of significant wasted effort, and a strongly negative motivator for the Coast Guard's performance oriented field personnel. The Research Results section reported that several minutes of documentation were saved by OIS after the end of each operational incident. It then quantified the benefits for the two reports directly tested, SARMIS and LEIS II. While those savings alone are substantial, they represent only the tip of the iceberg of operational reporting. They can be extrapolated to the many other reports and logs that field personnel maintain during operations.

The results of this extrapolation are displayed in Table 7. First, it assumes values for time savings that may be realized by consolidating or eliminating each report or log. Since no empirical data are available, this estimate is extremely conservative, allowing only a savings of one or two minutes per report. The three major departures from this rule are SITREPs and POLREPs, which are assumed to take an average of 30 minutes each; the Abstract of Operations Report, assumed to take 60 minutes once per quarter; and the MLE Weekly Feeder Report, assumed to take 10 minutes once per week. Interviews indicate that these estimates are also conservative. The MLE Weekly Feeder Report is not a title used uniformly throughout the Coast Guard; it is used only in the First District. However, it represents a general category of reports which are required by operational commanders in many areas. Some places call it a SAR Summary, others an Operational Summary. In some locales, it is required daily, in others weekly or even monthly. The assumptions here, ten minutes per unit per week, are on the low end of the scale.

Table 7 then estimates the number of reports per year which may are involved, and the labor rate of the pay grade that would typically complete each report. Finally, it calculates the annual benefit for each of the reports. It is likely that some of these individual estimates may be overstated, and others understated. However, they are believed to be quite conservative in the aggregate, and representative of the order of magnitude of the monetary value associated with doing the paperwork after the mission is over.

Table 7: Annual benefit of operational reports reduction, OIS Phase I.

| Report Type | Minutes saved per report | Reports per year | Hours saved per year | Labor Rate | Benefit, dollars per year |
|---|---|---|---|---|---|
| SARMIS entries | 7 | 40,000 | 4,800 | 17 | $81,600 |
| SEER Messages (Boardings) | 7 | 15,000 | 1,625 | 24 | $39,000 |
| SEER Messages (Sightings) | 2 | 10,000 | 333 | 24 | $8,000 |
| Boarding Report (CG 4100) | 2 | 15,000 | 500 | 24 | $12,000 |
| SITREPS (10% of SAR cases) | 30 | 2,500 | 1,250 | 24 | $30,000 |
| Distress checkoff sheet | 0 | | - | 17 | $0 |
| POLREPS | 30 | 2,500 | 1,250 | 24 | $30,000 |
| Abstract of Operations Rpt | 60 | 6,000 | 6,000 | 24 | $144,000 |
| SAR Case Folder | 3 | 40,000 | 2,000 | 17 | $34,000 |
| MLE Weekly Feeder Reports | 10 | 10,400 | 1,733 | 24 | $41,600 |
| Abbreviated Radio Log | 2 | 40,000 | 1,333 | 17 | $22,667 |
| Chrono log | 0 | | - | 17 | $0 |
| Unit Underway Hours log | 1 | 70,000 | 1,167 | 17 | $19,833 |
| Weather log | 0 | | - | 17 | $0 |
| Training log | 2 | 280,000 | 9,333 | 17 | $158,667 |
| Auxiliary Orders log | 0 | | - | 17 | $0 |
| SEER log | 1 | 15,000 | 250 | 17 | $4,250 |
| **Totals** | | | **31,575** | | **$625,617** |

As a point of comparison, the Small Boat Station Staffing Study results showed that Station personnel spend 6.2% of their 80-hour work weeks on paperwork. There are approximately 4,000 people at Stations, and their labor rates are approximately evenly distributed between $17 per hour and $24 per hour. This means an annual payroll of about $328 million. 6.2 % of this is $20M. If 10% of their paperwork time (0.62% of total time) is spent on *operational* reporting, then the total value of this time is $2 million annually. Both estimates agree within a factor of two, and indicate that substantial improvement is possible.

While no individual time saving is especially large, the cumulative effect is a substantial monetary investment in report writing. The quantifiable benefit is not large compared with the total cost of developing the Operational Information System. However, the intangible benefits of eliminating the negative motivation that results from our splintered operational reporting paradigm are substantial.

### 6.5.3 Improved Search Precision

The Coast Guard's Computer Aided Search Planning system (CASP) allows command center watchstanders to generate search patterns automatically. However, these patterns must be decomposed into descriptive text and transmitted to Search and Rescue Units (SRUs) by voice or text-based methods, then re-plotted or entered in SRU navigation systems. Finally, the SRU commander must manually navigate the craft through the search pattern and report results back to

the command center for effectiveness calculations. Using OIS to integrate CASP into the actual search execution instead of stopping at the planning stage would create significant improvements in search performance. It would also make even more substantial improvements in analyzing searches that did not locate the targets, and in planning subsequent searches.

The success of search efforts depends, in part, on the navigational precision of Search & Rescue Units (SRUs). For a variety of reasons, the performance of CG resources in search operations is described (from a strictly theoretical standpoint) as random. By improving navigational precision, the Coast Guard could make dramatic improvements in search capabilities, and lower costs. Even more important, we would expect to save more lives by (a) locating victims instead of not locating them, and (b) locating them sooner, before hypothermia and exposure have set in. The majority of this benefit would accrue to Phase II resources, predominantly aircraft, since they are the search platforms of choice and are high cost resources. Therefore, the detailed discussion underlying the search effectiveness improvements is presented in the Phase II benefits analysis in Appendix F. For this section of the report, suffice it to say that by improving the accuracy of search pattern execution, we can improve our search effectiveness. The discussion in Appendix F concludes that search effectiveness increases by 50% as a result of coupling OIS and CASP. These benefits are not capturable in the Coast Guard budget, but rather prevent us from having to spend additional search hours to achieve the same level of effectiveness.

## 6.6 SUMMARY

OIS provides the Coast Guard with a tool that can enable substantial business change and improvement. Its primary benefits lie in this potential. Investment in OIS gives program managers many opportunities to reduce overall costs and improve service.

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# 7. OIS PHASE I COST ESTIMATE

Cost estimates are considered Procurement Sensitive Information, release of which could detract from full and open competition in future acquisitions involving OIS. Therefore, this chapter has been deleted from the publicly available version of this report.

# 8. CONCLUSIONS AND RECOMMENDATIONS

## 8.1 CONCLUSIONS

The Group/Station Operational Information System Testbed was highly successful at meeting the primary Research and Development objective, to evaluate the concept of an integrated, cross-functional, distributed data system that links Coast Guard command centers and mobile resources. However, as was to be expected in a high-risk proof-of-concept effort, it failed to meet some of its technical goals. These problems, and testbed limitations, made it impossible to measure empirically the major benefits of OIS. The OIS Phase II work will seek to eliminate more of this uncertainty. However, the results of the Phase One Testbed provide valuable lessons learned so that future development, both in further R&D and in AC&I development, may be undertaken with substantially reduced risk. The following paragraphs present the major conclusions drawn from the Group/Station OIS Testbed.

We conclude it is technically feasible for the United States Coast Guard to implement the Operational Information System. Further, information technology has matured to the point that the Coast Guard can now implement the Operational Information System cost-effectively. Most underlying technologies are well developed, with none posing unacceptable technical risk. The highest risk technological areas in a full-scale deployment are distributed database technology, and robust packet-switched satellite communications.

Redundant data entry can be virtually eliminated. Automatic transfer of information from OIS to legacy systems such as SARMIS and LEIS II is a significant time saver, allowing greater focus on operations. This will also improve the work-life balance for Coast Guard people.

The Operational Information System is a critical enabler for the One Port/One Command Center concept. In order to consolidate functions physically, they must be consolidated logically. If the Coast Guard simply houses the same business functions in a single room without changing their component work processes, the total workload will remain unchanged, and the same level of staff will be required to support them. OIS provides the cross-functional information infrastructure necessary to complete the logical consolidation.

OIS will increase operational commanders' span of control and act as a force multiplier, allowing the agency to perform assigned missions with fewer resources. This enables organizational flattening, with less District/Group Commands. Combining OIS with the introduction of improved boats and aircraft will enable the Coast Guard to operate with fewer resources in the field. This is an important enabler in meeting the Commandant's third strategic goal: "meet the mandate to streamline with no reduction in essential services."

The Coast Guard should not implement pen-based computers for boarding officers at this time. The Group/Station Testbed results indicate that boarding officers felt a decrease in situational awareness. The next section contains a recommendation for further research in this promising area..

Embedding decision support functionality within OIS can improve the quality of decision making at all levels of the chain of command. It can also eliminate the need for extensive resident training on calculation and rule-based tasks. Training can focus on educating the person about the rationale behind performing tasks, but does not need to cover implementation details. This is especially valuable for tasks which are performed infrequently but are procedure-intensive. It also allows program managers to update policies and procedures easily by updating the decision support system.

OIS provides a tool for improved measurement of our operational services, and therefore better management of the resources. Capturing employment data as a byproduct of operations will increase accuracy and decrease workload.

## 8.2 RECOMMENDATIONS

Based on the results of the Group/Station Operational Information System Testbed, the Research and Development Center recommends the following.

That the Coast Guard continue development of the Operational Information System for Search and Rescue and Law Enforcement, as described in the functional decomposition in Appendix E, and deploy it Coast Guard-wide. This includes the functions currently performed by the Law Enforcement Information System II; the Search and Rescue Management Information System; and the Abstract of Operations System.

That the Coast Guard use the Operational Information System as a framework to integrate other major systems already in development. These include the Marine Safety Network and the Vessel Traffic System 2000. In addition to these major acquisitions, the Coast Guard has a substantial investment in the Navy's Joint Maritime Command Information System (JMCIS), or some of its variants. Both major cutters and major command centers ashore are currently users of these systems. This item will require that OIS exploit multi-level security technology.

That the Coast Guard implement the alternative in the Short Range Communications System proposals which includes the most capable data transfer capabilities, including secure data transmission.

That the Coast Guard implement a long range data communications system as part of an overall communications architecture designed to extend the existing shore-based wide area network to its operating resources.

That further research be done on human factors issues surrounding use of portable computers during boardings. The potential exists to improve the boarding process, but the results of the Group/Station Testbed were negative toward use of portable computers. This was clearly due in large part to technical flaws in the testbed system, but there remained a large unwillingness to commit to use of computers during boardings. The primary concern is that computers would require too much attention, detracting from the boarding party's situational awareness and safety. Unless further research indicates with a high degree of probability that design improvements can

eliminate the concern about situational awareness, we recommend against implementation of portable computers during boardings.

# APPENDIX A: DETAILED RESEARCH RESULTS

All 18 candidate metrics and the hypotheses they support are listed below. The ones selected for measurement are italicized. Metrics 1 and 2 are similar to metrics 8-11; the difference is that 1&2 apply to field personnel (boat crews), while 8-11 apply to command center personnel (OODs, RMOWs, watchstanders).

**A. OIS will reduce data entry and report preparation time.**
1. *Time to enter data in the field*
2. *Time to transcribe data in the field*
3. *Time to prepare reports*
4. Time spent on adhoc (on-request) reports
5. Amount of overtime

**B. OIS will increase accuracy and completeness of reports.**
6. Number of errors detected in manual case reviews
7. *Number of required and optional fields missing from reports*

**C. OIS will improve command and control by reducing $C^2$ response time.**
8. *Time to record data (at initial distress call)*
9. *Time to transcribe data into OIS*
10. *Time to identify resources*
11. *Time to dispatch*

**D. OIS will improve navigational accuracy of standard boats.**
12. Search pattern execution accuracy

**E. OIS will provide better on-scene information to field personnel.**
13. Number of effective LE boardings
14. Number of LEIS violations overturned
15. Number of recreational boating safety violations
16. Number of manuals accessed on board
17. Number of queries to LEIS II
18. Avoid doing the wrong boardings

The remainder of this appendix presents the raw results of the objective and subjective measures recorded during the OIS Phase One testbed.

## EXPERIMENT RAW DATA

### Experiment 1: Time Study

The raw data from the control group for this study were analyzed and found not to be reliable enough for valid analysis. Therefore, the results were not tabulated in a manner suitable for display. There is a detailed discussion of the factors surrounding this problem in Chapter 5, Research Results.

## Experiment 2: Report Preparation Time

Table 8 lists the raw data regarding SEER report preparation time, the pre-OIS LE reporting system. These data were collected at five Stations in Group Moriches during the spring of 1994.

Table 8: Pre-OIS LE reporting times.

| Date | SEER Msg Number | SEER Time | Number of Boardings | Time / Boarding |
|---|---|---|---|---|
| 4/12/94 | 3 | 30 | 1 | 30.0 |
| 4/21/94 | 4 | 15 | 1 | 15.0 |
| 4/22/94 | 5 | 25 | 2 | 12.5 |
| 4/24/94 | 6 | 21 | 3 | 7.0 |
| 4/25/94 | 7 | 16 | 1 | 16.0 |
| 4/19/94 | 9 | 30 | 4 | 7.5 |
| 4/22/94 | 10 | 18 | 2 | 9.0 |
| 4/25/94 | 11 | 18 | 2 | 9.0 |
| 4/25/94 | 12 | 12 | 1 | 12.0 |
| 5/13/94 | 13 | 12 | 1 | 12.0 |
| 5/14/94 | 14 | 18 | 1 | 18.0 |
| 5/14/94 | 15 | 24 | 2 | 12.0 |
| 5/15/94 | 16 | 24 | 3 | 8.0 |
| 5/17/94 | 17 | 45 | 4 | 11.3 |
| 5/18/94 | 18 | 40 | 2 | 20.0 |
| 5/19/94 | 33 | 15 | 0 | 0.0 |
| 6/9/94 | 17 | 45 | 4 | 11.3 |
| 6/14/94 | 18 | 40 | 2 | 20.0 |
| 5/8/94 | 10 | 18 | 2 | 9.0 |
| 5/12/94 | 11 | 18 | 2 | 9.0 |
| 5/19/94 | 12 | 12 | 1 | 12.0 |
| 5/21/94 | 13 | 12 | 1 | 12.0 |
| 5/27/94 | 14 | 18 | 1 | 18.0 |
| 6/4/94 | 15 | 24 | 2 | 12.0 |
| 6/6/94 | 16 | 24 | 3 | 8.0 |
| 4/24/94 | 9 | 30 | 4 | 7.5 |
| **Sum:** | | **604** | | **318** |
| **Count:** | | **26** | **52** | |
| **Mean:** | | **23.2** | **2.0** | **12.2** |
| **Std Dev:** | | **10.0** | | **5.7** |

Table 9 lists the raw data regarding post-OIS LE reporting. These data were collected in Group Long Island Sound during the summer of 1994.

Table 9: Post-OIS LE reporting time.

| Date | Boarding Number | Time to Validate |
|---|---|---|
| 8/5/94 | 145 | 3 |
| 8/5/94 | 146 | 4 |
| 8/5/94 | 147 | 3 |
| 8/6/94 | 148 | 3 |
| 8/6/94 | 149 | 3 |
| 8/6/94 | 150 | 3 |
| 8/7/94 | 151 | 4 |
| 8/7/94 | 152 | 4 |
| 8/8/94 | 153 | 3 |
| 7/21/94 | 110 | 10 |
| 7/21/94 | 111 | 10 |
| 7/21/94 | 114 | 10 |
| 7/28/94 | 123 | 9 |
| 7/29/94 | 124 | 14 |
| 7/30/94 | 126 | 4 |
| 7/30/94 | 127 | 4 |
| 7/30/94 | 128 | 4 |
| 7/30/94 | 130 | 3 |
| 7/30/94 | 131 | 5 |
| 7/30/94 | 132 | 4 |
| 7/30/94 | 133 | 5 |
| 7/30/94 | 134 | 5 |
| 7/30/94 | 135 | 7 |
| 7/31/94 | 136 | 5 |
| 7/31/94 | 137 | 5 |
| 7/31/94 | 138 | 5 |
| 8/1/94 | 139 | 4 |
| 8/1/94 | 140 | 2 |
| 8/2/94 | 141 | 3 |
| 8/3/94 | 142 | 5 |
| 8/5/94 | 144 | 4 |
| **Sum:** | | 157 |
| **Count:** | | 31 |
| **Mean:** | | 5.1 |
| **Std Dev:** | | 2.7 |

Table 10 lists the raw data regarding SARMIS report preparation time, the pre-OIS SAR reporting system. These data were collected at five Stations in Group Moriches during the spring of 1994.

Table 10: Pre-OIS SARMIS reporting times.

| Date | SARMIS Time | SITREP Time |
|---|---|---|
| 4/19/94 | 10 | |
| 4/19/94 | 10 | |
| 4/23/94 | 10 | |
| 4/23/94 | 10 | |
| 4/24/94 | 10 | 20 |
| 4/24/94 | 10 | |
| 4/18/94 | 10 | |
| 4/19/94 | 15 | 40 |
| 4/24/94 | 10 | |
| 4/24/94 | 12 | |
| 4/24/94 | 13 | |
| 4/24/94 | | 30 |
| 5/13/94 | 20 | |
| 5/13/94 | 20 | |
| 5/14/94 | 20 | |
| 5/14/94 | 20 | |
| 5/15/94 | 20 | |
| 4/18/94 | 12 | |
| 4/19/94 | 14 | |
| 4/21/94 | 10 | |
| 4/24/94 | 12 | |
| 4/24/94 | 10 | 20 |
| 4/27/94 | 10 | |
| 5/1/94 | 12 | |
| 5/1/94 | 10 | |
| 5/15/94 | 8 | |
| 5/21/94 | 10 | |
| 5/28/94 | 11 | |
| 5/28/94 | 10 | 45 |
| 5/28/94 | 10 | |
| 5/28/94 | 12 | |
| 5/28/94 | 10 | |
| 6/4/94 | 11 | |
| 6/15/94 | 15 | 45 |
| 7/2/94 | 10 | |
| 7/2/94 | 10 | |
| 7/3/94 | 10 | |
| 7/4/94 | 10 | |
| 7/5/94 | 10 | |
| 7/6/94 | 10 | 15 |
| 7/8/94 | 10 | |
| 3/6/94 | 10 | |
| 3/17/94 | 10 | |
| 3/19/94 | 8 | |
| 3/25/94 | 15 | |
| 3/26/94 | 10 | |
| 3/26/94 | 10 | |
| 3/26/94 | 10 | |
| 3/28/94 | 8 | |
| 3/30/94 | 10 | |
| 4/1/94 | 10 | |
| 4/4/94 | 5 | 45 |
| 4/7/94 | 10 | |
| 4/16/94 | 10 | |
| 4/18/94 | 10 | |
| 4/18/94 | 10 | |
| 4/22/94 | 10 | 35 |
| 4/22/94 | 10 | |
| 4/23/94 | 10 | |
| 4/24/94 | 5 | |
| 4/25/94 | 10 | |
| 4/26/94 | 5 | |
| 4/27/94 | 5 | 45 |
| 4/28/94 | 10 | |
| 4/28/94 | 10 | |
| 4/30/94 | 10 | |
| 5/13/94 | 15 | 45 |
| 5/13/94 | 5 | |
| 5/14/94 | 5 | |
| 5/15/94 | 10 | |
| 5/15/94 | 5 | |
| 5/16/94 | 10 | |
| 5/16/94 | 10 | |
| 5/17/94 | 5 | |
| 5/1/94 | 10 | |
| 5/2/94 | 10 | |
| 5/4/94 | 15 | |
| 5/9/94 | 10 | |
| 5/20/94 | 10 | |
| 5/21/94 | 10 | |
| 5/21/94 | 10 | |
| 5/21/94 | 15 | |
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| 5/30/94 | 10 | |
| 5/30/94 | 15 | |
| 5/30/94 | 10 | |
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| 5/30/94 | 10 | |
| 5/30/94 | 10 | |
| 5/31/94 | 10 | |
| 5/31/94 | 15 | |
| 5/31/94 | 10 | |
| 5/31/94 | 10 | |
| 5/31/94 | 10 | |
| 6/2/94 | 10 | |
| 6/3/94 | 10 | |
| 6/3/94 | 15 | |
| 6/4/94 | 12 | |
| 6/4/94 | 10 | |
| 6/4/94 | 15 | |
| 6/4/94 | 13 | |
| 6/4/94 | 12 | |
| 6/5/94 | 10 | |
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| 6/22/94 | 14 | |
| 6/22/94 | 12 | |
| 6/25/94 | 15 | |
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| 6/29/94 | 15 | |
| 6/30/94 | 12 | |
| 6/30/94 | 13 | |
| 8/1/94 | 10 | |
| 8/4/94 | 12 | |
| 8/4/94 | 12 | |
| 8/4/94 | 15 | |
| 8/6/94 | 15 | |
| 8/6/94 | 13 | |
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| 9/3/94 | 15 | |
| 9/4/94 | 10 | |
| 9/4/94 | 12 | |
| 9/4/94 | 10 | |
| 9/5/94 | 14 | |
| 9/5/94 | 10 | |
| 9/7/94 | 12 | |
| 9/9/94 | 10 | |
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| 9/11/94 | 15 | |
| 9/11/94 | 12 | |
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| 9/11/94 | 14 | |
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| 9/12/94 | 10 | |
| 9/13/94 | 10 | |
| 9/16/94 | 11 | |
| 9/16/94 | 11 | |
| 9/17/94 | 15 | |
| 9/17/94 | 11 | |
| 9/17/94 | 14 | |
| 9/17/94 | 11 | |
| 9/20/94 | 12 | |
| 9/21/94 | 15 | |
| 9/24/94 | 10 | |
| 9/25/94 | 12 | |
| **Sum:** | **3290** | **386** |
| **Count:** | **282** | **11** |
| **Mean:** | **11.7** | **36.0** |
| **Std Dev:** | **2.4** | **11.8** |

Table 11 lists the raw data regarding post-OIS LE reporting. These data were collected in Group Long Island Sound during the summer of 1994.

Table 11: Post-OIS SAR info validation times.

| Case Num | Time to Validate |
|---|---|
| 304 | 5.3 |
| 347 | 5.3 |
| 346 | 4.9 |
| 345 | 4.9 |
| 344 | 6.8 |
| 343 | 6.3 |
| 342 | 4.9 |
| 341 | 8.6 |
| 340 | 6.1 |
| 339 | 6.5 |
| 338 | 6.0 |
| 337 | 2.8 |
| 335 | 4.5 |
| 334 | 4.5 |
| 333 | 5.7 |
| 332 | 4.7 |
| 331 | 3.9 |
| 330 | 4.7 |
| 329 | 3.7 |
| 328 | 7.8 |
| 327 | 7.7 |
| 326 | 6.5 |
| 325 | 7.2 |
| 324 | 6.0 |
| 323 | 8.0 |
| 332 | 3.5 |
| 321 | 2.3 |
| 320 | 4.4 |
| 319 | 4.9 |
| 318 | 2.9 |
| 317 | 2.4 |
| 316 | 2.4 |
| 315 | 2.8 |
| 314 | 4.2 |
| 313 | 3.1 |
| 310 | 4.7 |
| 309 | 2.5 |
| 308 | 2.7 |
| 307 | 3.6 |
| 306 | 3.3 |
| 302 | 4.5 |
| 301 | 4.3 |
| 298 | 4.3 |
| 297 | 2.6 |
| 296 | 2.6 |
| 295 | 2.0 |
| 294 | 1.7 |
| 293 | 3.9 |
| 292 | 2.2 |
| **Sum:** | **221** |
| **Count:** | **49** |
| **Mean:** | **4.5** |
| **Std Dev:** | **1.8** |

**Experiment 3: Completeness of Information**

Table 12 lists the data elements which were missing in each of the case folders analyzed, identified as cases 1-10. These ten cases were part of the random sample of 20 cases used as part of this test.

Table 12: Completeness of case folders.

| Case Number | List of data elements missing |
|---|---|
| Case 1 | Time from Occurrence, Initial Severity, Date Case Closed |
| Case 2 | Vessel Name, Vessel Registration Number, Vessel Length, Vessel Usage, Number of people on Board |
| Case 3 | Date/Time Sortie Ended, Date/Time Case Closed |
| Case 4 | Latitude, Longitude, Time from Occurrence, Vessel Owner Name, Vessel Owner Address, Vessel Propulsion, Initial Severity, Reported Location Date/Time, Number of people on board, Type of Assistance Required |
| Case 5 | Vessel Registration Number, Vessel Owner Name, Vessel Owner Address |
| Case 6 | Total Time on Sortie, Total Time on Scene, Reporting Source, Method of Notification, Reported Latitude, Reported Longitude |
| Case 7 | Reported Latitude, Reported Longitude |
| Case 8 | Reported Latitude, Reported Longitude, Date/Time Incident Occurred, Assisting Resource Type, Distance to Scene or Search, Total Time on Sortie, Total Time on Scene, Method of Notification, Reporting Source, Vessel Length, Vessel Usage, Vessel Propulsion, Number of people on board, Initial Severity |
| Case 9 | Reported Latitude, Reported Longitude, Total Time on Sortie, Total Time on Scene, Reporting Source, Vessel Length, Vessel Usage, Vessel Propulsion, Initial Severity, Vessel Owner Name, Vessel Owner Address |
| Case 10 | Reported Latitude, Reported Longitude, Total Time on Sortie, Total Time on Scene, Reporting Source, Vessel Length, Vessel Usage, Vessel Propulsion, Initial Severity, Vessel Owner Name, Vessel Owner Address, Number of people on board |

## SURVEY RESPONSES

In the pages that follow, survey responses are tallied and percentages of respondents calculated for each answer. The tallies are presented in a framed section immediately following the question, which is in bold type. Immediately following each tally is a bulleted list of all user comments made in response to that question.

The blank questionnaires are presented immediately following the tallies.

## OIS Questionnaire 1 - Command and Control
## Respondents: Command center personnel, N=23

### When you answer a distress call, how do you record the information?

| | | |
|---|---|---|
| 1 | 5% | I type it directly into the computer |
| 7 | 33% | some info I type into the computer & some I write on paper -- which info/why? |
| 12 | 57% | I write it on paper -- why not use the computer? |
| 1 | 5% | n/a--I don't perform this function |

- *Some in computer, some on paper: I don't have time to type all the info and talk on the radio. So I usually just begin the case in OIS and fill out the blanks when I get the chance.*
- *Some in computer, some on paper: Initial info for case then into computer.*
- *Some in computer, some on paper: Faster to put initial info on paper.*
- *Some in computer, some on paper: Still easier for me to note then enter using paper checklists when necessary.*
- *On paper: In a distress case, it is easier for me to use pen/ink for quick important facts, and sort it out after.*
- *On paper: I'm more mobile with paper. I can write on paper then enter later - duplicate my effort?*
- *On paper: Because during the initial SAR call I want to be in the commcen, to make sure the proper info is gathered.*
- *On paper: I take the info and put it on the appropriate checklist required by the group. I can't type and hold the mike at the same time either.*
- *On paper: Sometimes you have to clear out one case to enter another. Takes too long.*
- *On paper: Easier to jot down quickly than to type.*
- *On paper: Takes too long.*
- *On paper: Often the information is passed so quickly that I feel more comfortable writing it down first then transferring.*
- *On paper: There's no way until the situation is under control.*
- *On paper: Quicker on paper in order to respond faster.*
- *On paper: I write down the info then type it into the computer. The info had to be recorded quickly.*
- *On paper: I write it on paper because I can write faster than I can type into a computer.*
- *On paper: I don't perform this function, but I see the watchstanders normally jot down the initial info and later record in OIS.*

### How easy or difficult is it to type/transcribe case data into the OIS system?

| | | |
|---|---|---|
| 3 | 14% | very easy |
| 17 | 77% | fairly easy |
| 1 | 5% | fairly difficult -- describe problems |
| 1 | 5% | unacceptably difficult -- describe problems |
| 0 | 0% | n/a--I haven't done this |

- *Fairly difficult: It wouldn't be so bad if it was one case at a time, we are usually running 2 or 3 at a time.*
- *Fairly difficult: Takes too long. Too much data is not applicable. Problems with computer slows process.*

- *Unacceptably difficult: OIS isn't intuitive. Icons and data entry into fields that may not apply to the task at hand detract from the task at hand - I'm SAR oriented.*

**How easy or difficult is it to retrieve (look up) case data in OIS?**

| | | |
|---|---|---|
| 7 | 32% | very easy |
| 13 | 59% | fairly easy |
| 2 | 9% | fairly difficult -- describe problems |
| 0 | 0% | unacceptably difficult -- describe problems |
| 0 | 0% | n/a -- I haven't done this |

- *Fairly difficult: When it's not crashing it's easy.*
- *Fairly difficult: Once archived, it's a bear to retrieve a lot of cases. I look at it from SARMIS coordinator aspect - needs work or a user name with some broader scope queries.*

**Do the Graphical Information System (GIS--the electronic map) and OIS affect how quickly you can identify and dispatch SAR boats on a case? Compared to the way you operated previously, would you say that the time to identify and dispatch SAR boats is:**

| | | |
|---|---|---|
| 0 | 0% | much faster with GIS/OIS |
| 1 | 5% | a little faster with GIS/OIS |
| 14 | 64% | about the same with GIS/OIS as before |
| 2 | 9% | a little slower with GIS/OIS -- describe problems |
| 2 | 9% | much slower with GIS/OIS -- describe problems |
| 3 | 14% | n/a--I haven't done this |

- *About the same: The position of the boat is 15 minutes from update to update. I still check the location of the UTB before I assume this is the current position.*
- *Much slower: Charted boat positions rarely accurate. Much easier to simply hail boat on VHF.*
- *A little slower: The screen did not function properly most of the time.*

**In your opinion, does the OIS system affect the ease with which case data are updated and shared between the group, stations, and SAR boats? Compared to the way you operated previously, would you say that:**

| | | |
|---|---|---|
| 2 | 9% | OIS makes it much more difficult to share and update case data -- why? |
| 2 | 9% | OIS makes it a little more difficult to share and update case data -- why? |
| 5 | 22% | OIS doesn't change our ability to share and update case data |
| 11 | 48% | OIS makes it a little easier to share and update case data |
| 3 | 13% | OIS makes it much easier to share and update case data |

- *Much more difficult: The system is always crashing.*
- *A little easier: Provided it's entered. Not easy to immediately find the new data. Have to search many fields to ferret out new data.*
- *A little more difficult: Some stations don't add info that should be added in a timely fashion.*
- *A little more difficult: Have experienced problems with other units using our OPFAC, making case ID difficult.*
- *A little easier: If everything is up and running properly it is easier to share info.*

**How has OIS affected the number of cases you can handle simultaneously? Compared to the way you operated previously, would you say that with OIS, you handle:**

| | | |
|---|---|---|
| 0 | 0% | more cases simultaneously than before? |

| | | |
|---|---|---|
| 14 | 64% | about the same number of cases as before? |
| 8 | 36% | fewer cases simultaneously than before? -- why? |

- *Fewer: It was rare the system was up. Either shoreside or u/w sorties.*
- *Fewer: Again, it is easier to write on a checklist than scroll through menus and screens.*
- *Fewer: More work than previously.*
- *Fewer: Too much computer work.*
- *Fewer: It takes me longer to change windows and move to previous case than it does to write it down.*
- *Fewer: If I'm working multiple cases I wait until they are all done before I type into OIS.*

**Do you ever have more cases than you can handle all at once? If so, what do you do? Has OIS affected this in any way?**

| | | |
|---|---|---|
| 12 | 57% | no |
| 9 | 43% | yes |

- *Yes: I get help from the CDO.*
- *Yes: I get another watchstander to answer the radio, write, answer phones, talk to group OOD. It gets hectic with or without OIS.*
- *Yes: Call in more watchstanders/OOD.*
- *Yes: Have someone help/forget about OIS.*
- *Yes: I usually get another person in the commcenter to answer the phones and to help out with other functions. OIS hasn't affected anything but when it is very busy there is no way I can use it and still do everything else.*
- *Yes: I ask Group for radio comms assistance.*
- *No: as long as I don't use OIS until the case is done.*

**Is there anything else you'd like us to know about your experiences with the OIS system?**

- *The shore-based system alone would be great.*
- *Validating cases becomes a problem when you have to enter a zero just to fill in a box.*
- *Input was very easy. Output was more difficult than it was prior to system (OIS).*
- *OIS shoreside should be installed everywhere SARMIS is used. It's a much easier system.*
- *OIS would work great at a station that handles a few cases (100-200 a year) where the commcen is set up so the watchstander has a foot pedal for the mike to keep their hands free. I hard/difficult to talk on the UHF with 1 hand and try to type OIS with 1 finger.*
- *When a case happens we retrieve a checkoff sheet for whatever the situation is and fill it out. The OIS would be more helpful if it were set up the same way. That should be the first screen we open - then get all other info.*
- *System frequently malfunctions, keyboard and trackball unreliable, transmission frequently down or not timely. Better, more durable hardware is a must. Pen-based is basically unusable and lack of reliability caused use to be infrequent. Shoreside system may have a future with some hardware upgrades. U/W system is not practical, ECDIS has future, but paper is here to stay as best possible system.*
- *Great concept! Make simpler, something more workable without tasking an already overtasked crew. PS: Possibly make Group run system.*
- *It's easier than SARMIS.*
- *The system is great. With some more work it could be very beneficial.*
- *I think we need like a basic typing class.*

## OIS Questionnaire 2 - Operational Reporting
**Respondents: Boat crews and station/group personnel, N=15**

**How often do you record SAR or LE case information and-or prepare SAR or LE reports?**

| | | |
|---|---|---|
| 14 | 82% | frequently |
| 1 | 6% | sometimes |
| 2 | 12% | almost never -- STOP HERE |

**(Pre-OIS) When you record case or boarding information on paper or forms, about how many minutes does it take...**

| N | mu | sigma | | | |
|---|---|---|---|---|---|
| 14 | 11.2 | 6.6 | min | (a) | for the average SAR case? |
| 11 | 16.1 | 9.4 | min | (b) | for the average LE case? |
| | | | | | n/a--I don't perform this function |

**(Pre-OIS) About how long does it take to prepare the necessary SAR and LE reports at the station?**

| N | mu | sigma | | | |
|---|---|---|---|---|---|
| 12 | 16.4 | 15.3 | min | (a) | for the average SAR case? |
| 10 | 16.9 | 6.9 | min | (b) | for the average LE case? |
| | | | | | n/a--I don't perform this function |

**(Pre-OIS) How easy or difficult is it to prepare these reports?**

| | | |
|---|---|---|
| 2 | 15% | very easy |
| 9 | 69% | fairly easy |
| 1 | 8% | fairly difficult -- describe problems |
| 0 | 0% | unacceptably difficult -- describe problems |
| 1 | 8% | n/a--I don't perform this function |

**The remaining questions should be asked during the POST-OIS data collection. The first four questions are for the boat crews; the rest of the questions are for all boat/station/group personnel involved in SAR/LE reporting.**

**(boat crew only) On most SAR and LE cases, how do you record information?**

| | | |
|---|---|---|
| 0 | 0% | into the pen-based computer only |
| 5 | 33% | some info into the computer & some on paper -- which info/why? |
| 6 | 40% | only onto paper -- why don't you use the computer? |
| 0 | 0% | n/a--I don't perform this function |
| 4 | 27% | no response |

- *Only onto paper: OIS pad difficult during u/w conditions. Touch screen marginal.*
- *Only onto paper: Too difficult.*
- *Only onto paper: Have to prepare for case and limited in the amount of time.*
- *Some into computer and some onto paper: You can use penbase in rough seas and takes twice as long to do job.*
- *Some into computer and some onto paper: Not always functioning*

**(boat crew only) When you record case or boarding information on paper or forms, about how many minutes does it take...**

| N | mu | sigma | | |
|---|---|---|---|---|
| 10 | 9.3 | 6.1 | min | (a) for the average SAR case? |
| 8 | 12.8 | 6.0 | min | (b) for the average LE case? |
| | | | | I don't record data onto paper or forms; I usually use the pen-based computer. |
| | | | | n/a--I don't perform this function |

- *Fairly difficult: Chasing icons and looking for required fields.*

**(boat crew only) When you record boarding data directly into the pen-based computer (that is, you don't write it on paper first), about how long does it take...**

| N | mu | sigma | | |
|---|---|---|---|---|
| 2 | 15.0 | 7.1 | min | (a) for the average SAR case? |
| 3 | 25.0 | 13.2 | min | (b) for the average LE case? |
| 1 | | | | I don't record data into the computer; I usually use paper. |
| | | | | n/a--I don't perform this function |

- *I don't: Paper first then OIS, near impossible to real-time.*

**(boat crew only) How easy or difficult is it to transmit SAR or boarding data from the pen-based computer to the OIS system at the station?**

| | | |
|---|---|---|
| 0 | 0% | very easy |
| 2 | 18% | fairly easy |
| 4 | 36% | fairly difficult -- describe problems |
| 1 | 9% | unacceptably difficult -- describe problems |
| 4 | 36% | n/a--I haven't done this |

- *Fairly difficult: Not always functioning. Easy when everything is working properly.*
- *Unacceptably difficult: Never reliable, time lapse too great.*

**All boat/station/group personnel involved in SAR/LE reporting.**

**When SAR or boarding information has been recorded onto paper first, about how long does it take to transcribe that information into the computer (either on board or at the station)...**

| N | mu | sigma | | |
|---|---|---|---|---|
| 11 | 14.4 | 6.4 | min | (a) for the average SAR case? |
| 9 | 15.3 | 7.2 | min | (b) for the average LE case? |

**How easy or difficult is it to transcribe SAR or boarding data from paper forms into the OIS system (either on board or at the station)?**

| | | |
|---|---|---|
| 3 | 20% | very easy |
| 8 | 53% | fairly easy |
| 2 | 14% | fairly difficult -- describe problems |
| 0 | 0% | unacceptably difficult -- describe problems |
| 2 | 14% | n/a--I haven't done this |

**How easy or difficult is it to prepare reports using the OIS system?**

| | | |
|---|---|---|
| 1 | 7% | very easy |

| | | |
|---|---|---|
| 10 | 67% | fairly easy |
| 2 | 13% | fairly difficult -- describe problems |
| 0 | 0% | unacceptably difficult -- describe problems |
| 2 | 13% | n/a--I haven't done this |

- *Fairly easy: when everything is working properly.*
- *Fairly difficult: Data transfer problems from OIS to CGSWS.*
- *Fairly difficult: It can be very time consuming sometimes waiting for screens to come up.*

**About how long does it take to use the OIS system to prepare the necessary reports...**

| N | mu | sigma | | |
|---|---|---|---|---|
| 12 | 10.1 | 6.3 | min | (a) for the average SAR case? |
| 8 | 12.1 | 8.0 | min | (b) for the average LE case? |
| | | | | I don't record data into the computer; I usually use paper. |
| | | | | n/a--I don't perform this function |

**How would you compare the time it takes to enter case or boarding data and prepare reports using the OIS system, compared to the way you used to do this?**

| | | |
|---|---|---|
| 4 | 27% | OIS takes much more time -- why? |
| 4 | 27% | OIS takes a little more time -- why? |
| 4 | 27% | OIS takes about the same amount of time |
| 2 | 13% | OIS takes a little less time |
| 0 | 0% | OIS takes much less time |
| 1 | 7% | no basis to compare |

- *OIS takes much more time: So many places to record info and summary spots.*
- *OIS takes much more time: You have to look around for proper icon to click on, wait for screen, perform scroll functions, and if you're lucky hope it doesn't crash which is time consuming.*
- *OIS takes much more time: File transfer time (OIS to CGSW) and editing data files.*
- *OIS takes a little more time: Have to bring up different screens.*
- *OIS takes a little more time: Transmit time, screen inputs timely.*
- *OIS takes a little more time: You have to add unnecessary data into OIS.*

**In your opinion, has the OIS system affected the accuracy of the information in the reports?**

| | | |
|---|---|---|
| 3 | 20% | accuracy has improved with OIS -- why? |
| 10 | 67% | accuracy is about the same |
| 2 | 13% | accuracy is worse with OIS -- why? |

- *Accuracy has improved: The mandatory fields prevent information from being left out or forgotten.*
- *Accuracy is worse with OIS: Sometimes when you enter information in OIS you're not sure if it will validate.*
- *Accuracy is worse with OIS: Its screens for some situations are too vague or non-existent.*
- *Accuracy is worse with OIS: Some data must be fabricated or omitted in order to successfully validate case folders.*

## OIS Questionnaire 3 - On-Scene Operations
**Respondents: Coxswains N=10**

Electronic Chart: The first few questions are about the electronic chart (ECDIS) and how it has affected your navigation tasks.

**How has the electronic chart (ECDIS) affected your time to arrive on station? Compared to navigating without ECDIS, would you say that with ECDIS:**

| | | |
|---|---|---|
| 4 | 40% | it takes much less time to arrive on station than before -- why? |
| 1 | 10% | it takes a little less time to arrive on station -- why? |
| 5 | 50% | it takes about the same amount of time as before |
| 0 | 0% | it takes a little more time to arrive on station -- why? |
| 0 | 0% | it takes much more time to arrive on station -- why? |

- *Little less: If you are navigating to an exact location/position such as a water depth you can visually watch the ECDIS instead of a radar fix or LORAN/GPS fix.*
- *Much less: Easy access to look at and a quick check on position.*
- *Much less: Takes away from majority of chart work.*
- *Much less: With the ECDIS and GPS you get a quicker look at where you are especially around the Thimbles area or any area in AOR.*

**How has the electronic chart (ECDIS) affected the accuracy of executing search patterns? Compared to navigating without ECDIS, would you say that with ECDIS search patterns are executed:**

| | | |
|---|---|---|
| 0 | 0% | much less accurately than before -- why? |
| 0 | 0% | a little less accurately -- why? |
| 5 | 50% | at about the same accuracy as before |
| 4 | 40% | a little more accurately -- why? |
| 1 | 10% | much more accurately than before -- why? |

- *Little more: The ECDIS can be used as a quick reference in between fixes to determine if you are being set. Also it is one more navigational aid to back up your navigation which improves accuracy and speed in navigation.*
- *Little more: Being used with GPS, it's bound to be more accurate.*
- *Much more: I could use the GPS and ECDIS to conduct a P/S search by watching the minutes on the lat/long to make my course changes and ultimately conduct a more thorough search.*
- *Much more: With the electronic chart you can see your tracklines which makes your search pattern more accurate.*
- *Much more: Much easier to check your course and keep your course.*

**How has the electronic chart (ECDIS) affected your navigational workload (that is, the amount of time and effort you must devote to the navigation task)? Compared to navigating without ECDIS, would you say that ECDIS:**

| | | |
|---|---|---|
| 4 | 40% | greatly decreases your navigation workload -- why? |
| 2 | 20% | slightly decreases your navigation workload -- why? |
| 4 | 40% | neither decreases nor increases your workload |
| 0 | 0% | slightly increases your navigation workload -- why? |
| 0 | 0% | greatly increases your navigation workload -- why? |

- *Greatly decreases: This is a sign of the times. Usually aids such as ECDIS are more accurate. This system will not take away from manually taking a fix, but it correlates the manual way of doing things with the effortless way of ECDIS.*
- *Greatly decreases: GPS is very accurate so by just looking at the chart you have displayed and comparing to your chart it takes less time to plot your position.*
- *Greatly decreases: You can draw your course on your chart and keep a good position where you are with ECDIS.*
- *Greatly decreases: ECDIS is extremely useful, it simply makes things easier.*
- *Slightly decreases: As a reference your position is fixed on the screen.*
- *Slightly decreases: It gives you more assurance of your current position.*
- *Neither: It is a valuable backup but not a substitute.*

**What do you like best about ECDIS?**

- *It is a valuable quick reference in between fixes and back up for positions.*
- *Easier navigating.*
- *Quick check.*
- *Makes overall job easier and allows you to shift more attention to the case.*
- *It is a highly visible aid. It is easy to get a quick reassurance of position.*
- *Visible aid. Double checks your navigation.*
- *When in the fog it gave me a more secure feeling of knowing exactly where I was at all times.*
- *I like the fact that it cuts down on my nav time and also gives a quick easy check on my position when running on a SAR call.*
- *Accuracy.*
- *Ready reference.*

**What do you like least about ECDIS?**

- *There is nothing not to like about it.*
- *The mouse and on-screen arrow are too sensitive and very difficult to use in any sea conditions.*
- *Having to scroll up and down for chart you need.*
- *Nighttime use and it's always going off and not receiving info.*
- *Mouse/cursor.*
- *Mouse was unusable in rough seas. The cursor didn't contrast with the chart.*
- *The mouse hardly works.*
- *Nothing.*
- *(1) It would crash when I hit large waves. (2) Can't see the cursor. (3) Get a headache trying to set up the system when u/w bouncing around.*

## Data Transmission with OIS

The next set of questions deals with the effects of using OIS to send and receive case information compared to using the voice radio.

**How do you transmit and receive case information to and from the station or group?**

| | | |
|---|---|---|
| 0 | 0% | Almost all information is transmitted and received via OIS. |
| 1 | 10% | Some info is via OIS, and some info is via radio. |
| | | 2% via OIS      98% via radio |

| | | |
|---|---|---|
| 9 | 90% | Almost all info is via radio -- why don't you use OIS? |

- *Almost all via radio: It is quicker and easier via radio.*
- *Almost all via radio: You must be alert and watching the situation. To enter info in OIS means you cannot do this.*
- *Almost all via radio: Inconsistent.*
- *Almost all via radio: Unreliable comms.*
- *Almost all via radio: OIS clutters up nav table and involves too much concentration into the pen-based.*
- *Almost all via radio: It takes a short time in our area to get on scene.*
- *Almost all via radio: You have to have a dedicated OIS operator to man the system. It takes less time to pass info via radio than it does to wait for info to be received via OIS.*
- *Almost all via radio: Takes too much time and also takes one of my personnel away from his normal duties. You need 04 personnel on the UTB to use OIS and run a case.*
- *Almost all via radio: Too slow.*

**How does OIS affect the time it takes you to transmit and receive case information (to and from the station or group)? Compared with using the radio, would you say that information transmission time with OIS is:**

| | | |
|---|---|---|
| 8 | 80% | much slower than using the radio -- why? |
| 0 | 0% | a little slower than using the radio -- why? |
| 2 | 20% | about the same as using the radio |
| 0 | 0% | a little faster than using the radio |
| 0 | 0% | much faster than using the radio |

- *Much slower: When transmitted by radio it can come almost immediately after it is received whereas by OIS it needs to be entered, sent, received which could take valuable minutes.*
- *Much slower: Needed information is transmitted faster via radio.*
- *Much slower: Too hard to use on a moving platform. Takes coxswain's eyes off situation.*
- *Much slower: I can talk faster than I can type!!*
- *Much slower: Radio is right now.*
- *Much slower: Until the system is perfected, some info never makes the screen.*
- *Much slower: It's easier to pick up a radio than get into a computer.*

**How does OIS affect the currency of the information you receive (that is, do you feel OIS enables you to keep more up-to-date on case progress)? Compared to using the radio, would you say that information currency with OIS is:**

| | | |
|---|---|---|
| 4 | 40% | much worse (less up-to-date) than with the radio -- why? |
| 1 | 10% | a little worse than with the radio -- why? |
| 4 | 40% | about the same as with the radio |
| 1 | 10% | a little better (more up-to-date) than with the radio |
| 0 | 0% | much better than with the radio |

- *A little worse: Most information on OIS is much easier passed over the radio. By the time I get OIS on line the case is half over.*
- *Much worse: Same as above. Radio is quicker.*
- *Much worse: Timely. We have secured frequencies.*
- *Much worse: I am also listening to the comms the station has with the vsl we are enroute to. Why do twice as much work?*
- *Much worse: Radio is right now.*

**How does OIS affect the accuracy of the case data you receive from the station/group/other units? Compared with using the radio, would you say that information accuracy with OIS is:**

| | | |
|---|---|---|
| 2 | 18% | much more accurate than with the radio |
| 1 | 9% | a little more accurate than with the radio |
| 4 | 36% | about the same accuracy as with the radio |
| 1 | 9% | a little less accurate than with the radio -- why? |
| 3 | 27% | much less accurate than with the radio -- why? |

- *Much more accurate: If it makes the screen there's no guessing about what the radioman said; it's right there on the screen.*
- *Much less accurate: Most OIS info is good for station OOD. Doesn't help with the case compared to the radio.*
- *Much less accurate: Again, radio is right now.*

**How does using OIS for transmitting/receiving information affect your workload (that is, the time and effort you devote to information transfer)? Compared to using the radio, would you say that with OIS:**

| | | |
|---|---|---|
| 4 | 40% | your workload is much greater than with the radio -- why? |
| 3 | 30% | your workload is a little greater than with the radio -- why? |
| 2 | 20% | your workload is about the same as with the radio |
| 1 | 10% | your workload is a little less than with the radio |
| 0 | 0% | your workload is much less than with the radio |

- *Much greater: We don't have the man hours to train people on the OIS to where it became second nature as in with talking on the radio.*
- *Much greater: During ops there has to be a dedicated person inputting data into OIS. With the radio the cox'n can carry out mission and talk on radio at same time.*
- *Much greater: More info to gather with a different medium. The radio is the only form of comms needed.*
- *A little greater: You have to wait for OIS to switch screens, then queue up the case I want transmitted, then send data immediately then TELL THE STATION I SENT THEM A CASE (on the radio).*
- *A little greater: Running with a 3-man crew gives the boat a navigator, helmsman, and a lookout. To take someone off one of these tasks to work OIS increases workload.*
- *A little greater: To operate OIS during a case takes a crewman away from the job at hand, by using radio you get info immediately.*
- *A little less: We're doing double the work now putting a case in OIS and then have to put it in our computer on base.*

**Is there anything else you'd like to tell us about the use of OIS for transmitting and receiving case information?**

- *I feel with a minimum crew of 3, the radio is much quicker and less confusing than OIS is while underway.*
- *Stick to the radio - you need another crewman to do this and another crewman can get in the way.*
- *Cellular telephone is too slow and unreliable. Satellite would be much better.*

## OIS Questionnaire 4 - Pen-Based Computer
## Respondents: Boarding Officers, N=13

### What do you like best about the pen-based computer?

- *Its ability to store pertinent information related to cases and comms with the OPCEN, LEIS, etc.*
- *The keypad/typewriter function, so the system will take the info, because it doesn't understand my handwriting.*
- *Basically nothing.*
- *The theory that it will save time.*
- *I do not like the pen-based at all.*
- *Keyboard.*
- *Nothing.*
- *Needed for the future/better way of doing things.*
- *The amount of features available.*
- *The foam cover.*
- *The picklists.*

### What do you like least about the pen-based computer?

- *Its relatively slow processing speed, and complicated picklists.*
- *Can't see it when there is a glare, cumbersome, affected by the wx, i.e. rain, mist.*
- *Reliability (lack of) and cumbersome equipment.*
- *Inconsistent transmit/receive.*
- *Time it takes to get it done.*
- *Everything. It is a tool we do not need. It makes our job harder than it needs to be.*
- *Too small.*
- *Very difficult.*
- *Life of battery.*
- *Too complicated, need special training to work pen-based.*
- *Too much info needs to be garnished, i.e. some cases are not so info rich.*
- *Takes too much time.*

### How would you rate the overall acceptability of performance of the pen-based computer? Would you say its performance is:

| | | |
|---|---|---|
| 0 | 0% | excellent |
| 3 | 23% | good |
| 6 | 46% | fair -- why? |
| 4 | 31% | unacceptable -- why? |

- *Fair: Processing is slow (you wait a long time when calling up new screens, etc.). Picklists esp. for LE boardings are too complicated. If the picklists were simpler (i.e. resembling a 4100 form) and machine were faster the system would be excellent.*
- *Unacceptable: It takes an easy task and makes it difficult.*
- *Unacceptable: Too much to take on a vessel you are boarding. Operator has to concentrate too much on pen-based. Takes away from crew and weapon awareness.*
- *Fair: Format is difficult to work with, i.e. should use standard 4100 form.*
- *Unacceptable: Most people that have been boarded say that it takes too long.*

- *Fair: The way the pen-based is set up you have to be a wizard to work the system. Crewmembers (BMs and MKs) hard to get from screen to screen.*
- *Fair: Somewhat slow and unreliable. The screens are different than the shoreside system.*
- *Unacceptable: I think if the pen-based was more like the 4100 form it would be more useful and take less time.*

**How do you use the pen-based computer? (check all that apply)**

| | | |
|---|---|---|
| 1 | 8% | Not at all--I always take data on paper and never enter it into the pen-based computer. |
| 6 | 50% | I have taken it with me on boardings and entered boarding data directly into the pen-based computer (no paper). |
| | | How often do you take it on boardings? |
| | | 7 rarely |
| | | 1 sometimes |
| | | 0 almost always |
| 9 | 75% | I have taken boarding data on paper, and then entered it into the pen-based computer when I returned to my boat. |
| 7 | 58% | I have used the pen-based computer to transmit boarding data from the boat to the station/group. |
| 1 | 8% | other (describe) |

- *Have used it on occasion during SAR cases to send communication to the commcen and to keep a chrono.*
- *I have had to reenter data because the pen-based data didn't arrive at the station due to comms problems. The case stayed at the group. I had to reenter the SABR and make another 4100 form for my records anyway.*

**Answer the questions on this page only if you have taken the pen-based computer on boardings (otherwise, skip to the next page).**

**How easy or difficult is it to find the screens you need to use?**

| | | |
|---|---|---|
| 0 | 0% | very easy |
| 7 | 54% | fairly easy |
| 4 | 31% | fairly difficult -- describe problems: |
| 0 | 0% | unacceptably difficult -- describe problems: |
| 2 | 15% | no answer |

- *Fairly difficult: Often while on one screen I would need info from another. Finding that info takes a long time (i.e. date of birth for POB), where on a 4100 I could just glance up and find it. If screens were more consolidated and simpler it would solve this.*
- *Fairly difficult: Takes too much time.*
- *Fairly difficult: Screens not the same as shoreside and transmission is not always reliable.*

**How easy or difficult is it to use the pen to write words and numbers on the screen?**

| | | |
|---|---|---|
| 0 | 0% | very easy |
| 2 | 15% | fairly easy |
| 5 | 38% | fairly difficult -- describe problems |
| 5 | 38% | unacceptably difficult -- describe problems |

| | | |
|---|---|---|
| 1 | 8% | no answer |

- *Fairly difficult: It's hard to write a 4100 let alone get a computer to understand your writing while bouncing around.*
- *Fairly difficult: Weather conditions hamper it.*
- *Fairly difficult: It always reads it as something else.*
- *Fairly difficult: Tough in rough weather.*
- *Unacceptably difficult: Doesn't recognize all handwriting.*
- *Unacceptably difficult: The time I tried to write the computer seldom recognized my writing. I always use the keyboard. 20 min to 15 min average boarding time.*
- *Fairly difficult: The pens used sometimes don't work - screen doesn't take input.*
- *Unacceptably difficult: Not good enough to recognize everybody's hand.*

**How easy or difficult is it to enter numbers by scrolling?**

| | | |
|---|---|---|
| 7 | 64% | very easy |
| 4 | 36% | fairly easy |
| 0 | 0% | fairly difficult -- describe problems |
| 0 | 0% | unacceptably difficult -- describe problems |
| 0 | 0% | no answer |

**How would you rate the weight of the pen-based computer?**

| | | |
|---|---|---|
| 1 | 8% | too light |
| 9 | 75% | about the right weight |
| 0 | 0% | a little too heavy |
| 2 | 17% | moderately heavy, but acceptable |
| 0 | 0% | unacceptably heavy |

**Have you had any problem with the following aspects?**

| | NO | | YES | |
|---|---|---|---|---|
| Battery life | 7 | 24% | 5 | 71% |
| Water-proof | 11 | 38% | 1 | 14% |
| Ruggedness | 11 | 38% | 1 | 14% |

- *Yes, battery life: Battery life is difficult, it would be great to have an extended battery system.*
- *Yes, battery life: Sometimes in the middle of a boarding the pen-based will go out.*
- *Yes, waterproof-ness: Can't be used when it rains. When left on UTB the screen gets moisture inside of it and fogs up.*
- *Yes, ruggedness: The unit was dropped and the battery cover was lost overboard, but the unit continued to work. It seems to be rugged.*

**How could the pen-based computer be improved?**

- *(1) Make 1 or 2 windows with only the picklists found on a 4100 form, and one screen for supplemental material (i.e. voyage-cargo-comments). These items are complicated under the present setup. (2) Give it a faster processor. Switching from screen to screen takes a long time.*
- *Somehow make the system a one-screen unit so everything is on that screen. Also make it touch screen.*
- *Continue to use 4100's.*
- *Improve the screen so the user can see the data in direct sunlight. Better mounting station.*

- *Get rid of it. Put a small version of the shoreside OIS computer on the 41 footer. Use it like a police car. Pass the documentation to the OIS operator. BO does boarding while boat generates the report.*
- *By changing the format to standard 4100 and 4100S.*
- *You should make it look just like the 4100 form and should not be used at all on boats for SAR cases.*
- *Maybe picklist with forms examp: 4100 etc.*
- *Have a mirror of the paper 4100, including 4100F and 4100S. Also a plain paper printout format would be good.*
- *Easier to use, quicker.*
- *If a screen came up that looks just like the 4100 form and then you could pick what section you want to go into and fill out. Such as if I had a screen of the 4100 form I could see # of POB and put in the number of POB, then go to personnel info without shifting screens it would all be there in front of me like the 4100 form.*

**Is there anything else you'd like to tell us about the pen-based computer?**

- *The concept of using the pen-based computer is excellent - it has the potential of eliminating needless ops such as entering boardings into SABR which could be done directly, once. Most of its features work well and are dependable. The time that is wasted using the complicated picklists, however, makes it unusable in its present form. Many boaters have made the comment that the machine takes too long - and have said they don't understand why our machines can't operate more quickly like the ones used by United Parcel Service. The simple changes to the software of consolidated picklists etc. and faster speed would solve those problems.*
- *Very difficult to see when the sun is out. It sometimes jeopardizes BO safety when you have to avoid the sun or glare, and this is a self-conscious move.*
- *It takes too much time and effort on board to get information transmitted and received. Takes up coxswain's chart table space. During a boarding too much time is spent looking at the pen-based and not on the POBs.*
- *It's a good idea, it just needs to go back to the drawing board for a little while. You need to get a team of BO's together from the targeted area where it will be used and have them give you ideas. Get the E-4's and E-5's that will be using it, ask them where, what, and how.*
- *Great idea. Unit personnel need more time to become familiar with unit before using it in the field.*
- *I think that if you can not make the screen look like the 4100 form, they should scrap the project.*
- *System will work. Needs fine tuning. Make it more user friendly.*
- *Good concept. I would be interested in further exploration with this system if improved.*

## Blank Survey Forms

The next 12 pages present the data collection forms used in the objective measures portion of the research, and the blank survey forms used for the subjective comments gathering.

Group/Station: ______________________

# SARMIS Report Prep

The Coast Guard R&D Center is developing a new computer system (called OIS) which is aimed at simplifying the report preparation for SAR and LE cases. We need to collect data on current reporting methods in order to make comparisons with the new system. Please use this form to keep track of your SARMIS Reports. At the end of each week, please fax the form(s) to: Dr. Anita Rothblum, R&DC, (203) 441-2792.

**Time:** time taken to prepare one SARMIS report (do *not* count time spent reviewing report; count only data entry time). Record time in minutes: either write in total time (e.g., "9"), or else write in start/stop times (e.g., "10:15/10:24").

| Date | SAR Case # | Time to prepare SARMIS (minutes) |
|---|---|---|
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Group/Station: ____________________

# SITREP Preparation

**Time to prepare SITREP:** time taken to prepare one SITREP (do *not* count time spent reviewing report; count only data entry time). Record time in minutes: either write in total time (e.g., "9"), or else write in start/stop times (e.g., "10:15/10:24").

| Date | SAR Case or LE Boarding | | Time to prepare SARMIS (minutes) |
|---|---|---|---|
| | SAR Case # or LE Boarding # | Circle Type | |
| | | SAR LE | |
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Group/Station: ____________________

# SEER Report Prep

The Coast Guard R&D Center is developing a new computer system (called OIS) which is aimed at simplifying the report preparation for SAR and LE cases. We need to collect data on current reporting methods in order to make comparisons with the new system. Please use this form to keep track of your SEER Reports. At the end of each week, please fax the form(s) to: Dr. Anita Rothblum, R&DC, (203) 441-2792.

**Report #:** The I.D. number assigned to this SEER report.

**LE Boardings:** Total number of LE boardings being reported in one SEER report.

**Violations:** Total number of violations reported in the SEER. For example, if the SEER discusses two boardings, and if one boarding resulted in two violations, and a second resulted in 1 violation, the total violations would be "3".

**Time:** time taken to prepare one SEER report (do *not* count time spent reviewing report; count only data entry time). Record time in minutes: either write in total time (e.g., "9"), or else write in start/stop times (e.g., "10:15/10:24").

| Date | SEER **Report #** | Total Number of **LE Boardings** in this SEER report | Total Number of **Violations** in this SEER report | **Time** (in minutes) to prepare this SEER report |
|---|---|---|---|---|
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Group/Station: ____________________

# Ad-Hoc Reports

Group Operations Officer: Please tally the requests for ad-hoc reports and the labor required to generate them.

| Report ID | Brief Description | Labor to Produce Report | | |
|---|---|---|---|---|
| | | Unit | Pay Grade | Labor Hours |
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Group/Station: ____________________

# SARMIS Report Prep with OIS

Please use this form to record time spent on SARMIS Reports. At the end of each week, please fax the form(s) to: Dr. Anita Rothblum, R&DC, (203) 441-2792. Thanks!

**Time to Validate SAR Case in OIS**: How long did it take you to validate this case? Start counting when, after the case is over, you first click the Validate button. Stop counting when OIS reports, "Situation Validated Successfully!"

**Who validated this case?** Enter the name and rank of the person who validated this case in OIS.

**Time to transfer SARMIS to OIS:** How long did it take you to transfer this case to the Standard Workstation? Start when you open the Report Controller to generate the SARMIS reports. End when the Standard Workstation program that transfers the data has finished running, and the data is on the Standard Workstation. If you do more than one case at a time, enter the time required for all of them, and the range of case numbers. We will divide the total time by the number of cases to determine your average time per case.

| Date | SAR Case # | OIS Situation Name | Time to **Validate** SAR Case in OIS | **Who** validated this case? | Time to **transfer** data to OIS |
|---|---|---|---|---|---|
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Group/Station: ______________________

# SITREP Preparation in OIS

**Time to edit SITREP:** time taken to edit one SITREP generated by OIS. Record time in minutes: either write in total time (e.g., "9"), or else write in start/stop times (e.g., "10:15/10:24").

| Date | SAR Case or LE Boarding | | Time to edit OIS-generated SITREP (minutes) |
|---|---|---|---|
| | OIS Situation Name | Circle Type | |
| | | SAR LE | |
| | | SAR LE | |
| | | SAR LE | |
| | | SAR LE | |
| | | SAR LE | |
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| | | SAR LE | |
| | | SAR LE | |

Group/Station: ____________________

# Law Enforcement Report Prep with OIS

Please use this form to record time spent on SARMIS Reports. At the end of each week, please fax the form(s) to: Dr. Anita Rothblum, R&DC, (203) 441-2792. Thanks!

**Time to Validate this Boarding in OIS**: How long did it take you to validate this boarding? Start counting when, on the shoreside system, you first click the Validate button. Stop counting when OIS reports, "Situation Validated Successfully!"

**Who validated this boarding?** Enter the name and rank of the person who validated this case in OIS.

**Time to transfer Boarding to OIS:** How long did it take you to transfer this case to the Standard Workstation? Start when you open the Report Controller to generate the SARMIS reports. End when the Standard Workstation program that transfers the data and loads it into LEIS II has finished running, and the data is in LEIS II.

| Date | LE Boarding # | OIS Situation Name | Time to **Validate** Boarding | **Who** validated this Boarding? | Time to **transfer** data to OIS |
|---|---|---|---|---|---|
| | | | | | |
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Group/Station: ____________________

# Ad-Hoc Reports with OIS

Group Operations Officer: Please tally the requests for ad-hoc reports and the labor required to generate them.

| Report ID | Brief Description | Labor to Produce Report | | |
|---|---|---|---|---|
| | | Unit | Pay Grade | Labor Hours |
| | | | | |
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Circle: NH, NL, EN date: ___________

# Report Preparation (Routine)

Include routine reports, such as SARMIS, LEIS II, Abstract of Ops, SAR case folders, Distress checkoff sheets, SAR SITREPs, POLREPs, Ops Normal and Position Reports, MLE Weekly Feeder Report, Unit Log, Chrono logs, Radio logs, Underway Hours Log, and Weather Log.

**Who?:** job of person who prepares or reviews the report (e.g., BO, GODO, etc.)

**Prepare:** time taken to enter data into report forms, or to have OIS generate the report for you.

**Review:** time taken to check over the report for accuracy and completeness and correct any errors.

**Time:** times in minutes. Either write in total time (e.g., "9"), or else write in start/stop times (e.g., "10:15/10:24").

| SAR Case # or LE Boarding # | Who? (BO, GODO, | Report Name | Time to **prepare** report (minutes) | Time to **review** report (minutes) |
|---|---|---|---|---|
| # SAR LE | | | | |
| # SAR LE | | | | |
| # SAR LE | | | | |
| # SAR LE | | | | |
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| # SAR LE | | | | |
| # SAR LE | | | | |
| # SAR LE | | | | |
| # SAR LE | | | | |
| # SAR LE | | | | |
| | | Boat Abstract | | |
| | | Case Folder | | |
| | | MLE Weekly Feeder | | |
| | | Monthly SAR Summary | | |
| | | Monthly Weather Report | | |

Circle: NH, NL, EN date: ____________

# Boat Crew Log

**Collect:** The time required to write SAR or boarding data in logs, notebooks, or scratch paper; includes all case data gathered by boat crew.

**Data from?** person or resource from who information is collected. *Code as follows:*
"GLIS", "EN", "NH", "NL";
"Boat" for CG small boats from EN, NH, or NL *only*;
"Other" for any other CG resource (boats from other stations, helos, CG auxiliary) or any police or civilian resource, or the disabled vessel.

| SAR Case or LE Boarding | | | Who? | Collect Data from? | **Time to Collect Data** |
|---|---|---|---|---|---|
| SAR Case# or LE Boarding# | circle type | if LE, linked to SAR? | (Cox'n, BO, etc.) | (GLIS, EN, NH, NL, Boat, Other) | (min:sec) |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |
| | SAR LE | Yes No | | | |

Circle: NH, NL, EN

# OPCEN Log

Case Start Date and Time ______________ Case Finish Date and Time ______________ Case # ________ MUC # ________

Vessel Name ______________________ Incident type and severity ______________________

Briefly Describe Case:

Observer: record Start/Stop times (e.g., 091/0915) for each instance of each category for a given case.

| **distress call** | **start/stop** | **start/stop** | **start/stop** | **start/stop** | **start/stop** | **start/stop** |
|---|---|---|---|---|---|---|
| radio or phone call | | | | | | |
| write info on paper | | | | | | |
| **ID and dispatch** | | | | | | |
| identify resources | | | | | | |
| dispatch resources | | | | | | |
| number of resources: ____ CG Boats ____ Auxiliary ____ CG Aircraft ____ Other (police, salvage, etc.) | | | | | | |
| **comms (case-related)** | | | | | | |
| investigative calls | | | | | | |
| contact Group/Station (GLIS< EN, NH, or NL *only*) | | | | | | |
| contact CG boats (EN, NH, NL *only*) | | | | | | |
| contact others (Aux., helos, other CG, police, salvage, distressed vsl, etc.) | | | | | | |
| **case admin** | | | | | | |
| review case data | | | | | | |
| other (describe) | | | | | | |
| **reports and logs** | | | | | | |
| SARMIS | | | | | | |
| SEER | | | | | | |
| MARBs | | | | | | |
| SMIBs | | | | | | |
| UMIBs | | | | | | |
| Chrono Log | | | | | | |
| Weather Log | | | | | | |

** attach copy of Chrono and any notes **

**OIS Survey - Pen-Based Computer**
(Boarding Officer - POST-OIS)

Name________________ ☐ Job__BO__ ☐ Station____ ☐ Date____ ☐

General Hardware and Software

What do you like best about the pen-based computer?

What do you like least about the pen-based computer?

How would you rate the overall acceptability of performance of the pen-based computer? Would you say its performance is:

- ___☐ excellent
- ___☐ good
- ___☐ fair → why?
- ___☐ unacceptable → why?

How do you use the pen-based computer? *(check all that apply)*

- ___☐ Not at all--I always take data on paper and never enter it into the pen-based computer.
- ___☐ I have taken it with me on boardings and entered boarding data directly into the pen-based computer (no paper). ↓

  How often do you take it on boardings?

  ___☐ almost always ___☐ sometimes ___☐ rarely
- ___☐ I have taken boarding data on paper, and then entered it into the pen-based computer when I returned to my boat.
- ___☐ I have used the pen-based computer to transmit boarding data from the boat to the station/group.
- ___☐ other (describe)

*Answer the questions on this page* *only if* *you have taken the pen-based computer on boardings (otherwise, skip to the next page).*

How easy or difficult is it to find the screens you need to use?

- ___☐ very easy
- ___☐ fairly easy
- ___☐ fairly difficult → describe problems
- ___☐ unacceptably difficult → describe problems

How easy or difficult is it to use the pen to write words and numbers on the screen?

- ___☐ very easy
- ___☐ fairly easy
- ___☐ fairly difficult → describe problems
- ___☐ unacceptably difficult → describe problems

How easy or difficult is it to enter numbers by scrolling?

- ___☐ very easy
- ___☐ fairly easy
- ___☐ fairly difficult → describe problems
- ___☐ unacceptably difficult → describe problems

How would you rate the weight of the pen-based computer?

- ___☐ too light
- ___☐ about the right weight
- ___☐ a little too heavy
- ___☐ moderately heavy, but acceptable
- ___☐ unacceptably heavy

Have you had any problem with:

| | | |
|---|---|---|
| Battery life | ___☐ no | ___☐ yes → describe |
| Water-proofness | ___☐ no | ___☐ yes → describe |
| Ruggedness | ___☐ no | ___☐ yes → describe |

How could the pen-based computer be improved?

Is there anything else you'd like to tell us about the pen-based computer?

**OIS Survey - Operational Reporting**
(boat crews and station/group personnel - PRE- and POST-OIS)

Name____________________☐ Job_______☐ Station_____☐ Date_____☐

How often do you record SAR or LE case information and-or prepare SAR or LE reports?
___☐ frequently
___☐ sometimes
___☐ almost never → STOP HERE

*The rest of the questions on this page should be asked during the PRE-OIS data collection.*

*(Pre-OIS)* When you record case or boarding information on paper or forms, about how many minutes does it take...
(a) for the average SAR case? ___☐ minutes
(b) for the average LE case? ___☐ minutes
___☐ n/a--I don't perform this function

*(Pre-OIS)* About how long does it take to prepare the necessary SAR and LE reports at the station?
(a) for the average SAR case? ___☐ minutes
(b) for the average LE case? ___☐ minutes
___☐ n/a--I don't perform this function

*(Pre-OIS)* How easy or difficult is it to prepare these reports?
___☐ very easy
___☐ fairly easy
___☐ fairly difficult → describe problems
___☐ unacceptably difficult → describe problems
___☐ n/a--I don't perform this function

*These questions should be asked during the POST-OIS data collection. The first four questions (this page) are for the boat crews; the rest of the questions (next two pages) are for all boat/station/group personnel involved in SAR/LE reporting.*

*(boat crew only)* On most SAR and LE cases, how do you record information?

- ___☐ into the pen-based computer only
- ___☐ some info into the computer & some on paper → which info/why?
- ___☐ only onto paper → why don't you use the computer?
- ___☐ n/a--I don't perform this function

*(boat crew only)* When you record case or boarding information on paper or forms, about how many minutes does it take...

(a) for the average SAR case? ___☐ minutes
(b) for the average LE case? ___☐ minutes

- ___☐ I don't record data onto paper or forms; I usually use the pen-based computer.
- ___☐ n/a--I don't perform this function

*(boat crew only)* When you record boarding data directly into the pen-based computer (that is, you don't write it on paper first), about how long does it take...

(a) for the average SAR case? ___☐ minutes
(b) for the average LE case? ___☐ minutes

- ___☐ I don't record data into the computer; I usually use paper.
- ___☐ n/a--I don't perform this function

*(boat crew only)* How easy or difficult is it to transmit SAR or boarding data from the pen-based computer to the OIS system at the station?

- ___☐ very easy
- ___☐ fairly easy
- ___☐ fairly difficult → describe problems
- ___☐ unacceptably difficult → describe problems
- ___☐ n/a--I haven't done this

*All boat/station/group personnel involved in SAR/LE reporting.*

When SAR or boarding information has been recorded onto paper first, about how long does it take to transcribe that information into the computer (either on board or at the station)...

(a) for the average SAR case? ___☐ minutes
(b) for the average LE case? ___☐ minutes
___☐ I usually record data into the pen-based computer, so I don't need to transcribe it.
___☐ n/a--I don't perform this function

How easy or difficult is it to transcribe SAR or boarding data from paper forms into the OIS system (either on board or at the station)?

___☐ very easy
___☐ fairly easy
___☐ fairly difficult → describe problems
___☐ unacceptably difficult → describe problems
___☐ n/a--I haven't done this

How easy or difficult is it to prepare reports using the OIS system?

___☐ very easy
___☐ fairly easy
___☐ fairly difficult → describe problems
___☐ unacceptably difficult → describe problems
___☐ n/a--I haven't done this

About how long does it take to use the OIS system to prepare the necessary reports...

(a) for the average SAR case? ___☐ minutes
(b) for the average LE case? ___☐ minutes
___☐ n/a--I don't perform this function

How would you compare the time it takes to enter case or boarding data and prepare reports using the OIS system, compared to the way you used to do this?

____ ☐ OIS takes much more time → why?
____ ☐ OIS takes a little more time → why?
____ ☐ OIS takes about the same amount of time
____ ☐ OIS takes a little less time
____ ☐ OIS takes much less time

In your opinion, has the OIS system affected the *accuracy* of the information in the reports?

____ ☐ accuracy has improved with OIS → why?
____ ☐ accuracy is about the same
____ ☐ accuracy is worse with OIS → why?

**OIS Survey - Command and Control**
(all command center personnel - POST-OIS)

Name______________________ ☐ Job________ ☐ Station______ ☐ Date______ ☐

When you answer a distress call, how do you record the information?
- ____☐ I type it directly into the computer
- ____☐ some info I type into the computer & some I write on paper → which info/why?
- ____☐ I write it on paper → why not use the computer?
- ____☐ n/a--I don't perform this function

How easy or difficult is it to type/transcribe case data into the OIS system?
- ____☐ very easy
- ____☐ fairly easy
- ____☐ fairly difficult → describe problems
- ____☐ unacceptably difficult → describe problems
- ____☐ n/a--I haven't done this

How easy or difficult is it to retrieve (look up) case data in OIS?
- ____☐ very easy
- ____☐ fairly easy
- ____☐ fairly difficult → describe problems
- ____☐ unacceptably difficult → describe problems
- ____☐ n/a--I haven't done this

Do the Graphical Information System (GIS--the electronic map) and OIS affect how quickly you can identify and dispatch SAR boats on a case? Compared to the way you operated previously, would you say that the time to identify and dispatch SAR boats is:
- ____☐ much faster with GIS/OIS
- ____☐ a little faster with GIS/OIS
- ____☐ about the same with GIS/OIS as before
- ____☐ a little slower with GIS/OIS → describe problems
- ____☐ much slower with GIS/OIS → describe problems

In your opinion, does the OIS system affect the ease with which case data are updated and shared between the group, stations, and SAR boats? Compared to the way you operated previously, would you say that:
- ____☐ OIS makes it much more difficult to share and update case data → why?
- ____☐ OIS makes it a little more difficult to share and update case data → why?
- ____☐ OIS doesn't change our ability to share and update case data

- ___ ☐ OIS makes it a little easier to share and update case data
- ___ ☐ OIS makes it much easier to share and update case data

How has OIS affected the number of cases you can handle simultaneously? Compared to the way you operated previously, would you say that with OIS, you handle:

- ___ ☐ more cases simultaneously than before?
- ___ ☐ about the same number of cases as before?
- ___ ☐ fewer cases simultaneously than before? → why?

Do you ever have more cases than you can handle all at once?

- ___ ☐ no
- ___ ☐ yes → what do you do? Has OIS affected this in any way?

Is there anything else you'd like us to know about your experiences with the OIS system?

**OIS Survey - On-Scene Operations**
(Coxswain - POST-OIS)

Name__________________ ☐ Job_COXiN ☐ Station____ ☐ Date____ ☐

Electronic Chart
*The first few questions are about the electronic chart (ECDIS) and how it has affected your navigation tasks.*

How has the electronic chart (ECDIS) affected your *time to arrive on station*? Compared to navigating without ECDIS, would you say that with ECDIS:

___☐ it takes much less time to arrive on station than before → why?
___☐ it takes a little less time to arrive on station → why?
___☐ it takes about the same amount of time as before
___☐ it takes a little more time to arrive on station → why?
___☐ it takes much more time to arrive on station → why?
___☐ n/a--don't use ECDIS

How has the electronic chart (ECDIS) affected the *accuracy of executing search patterns*? Compared to navigating without ECDIS, would you say that with ECDIS search patterns are executed:

___☐ much less accurately than before → why?
___☐ a little less accurately → why?
___☐ at about the same accuracy as before
___☐ a little more accurately → why?
___☐ much more accurately than before → why?
___☐ n/a--don't use ECDIS

How has the electronic chart (ECDIS) affected your *navigational workload* (that is, the amount of time and effort you must devote to the navigation task)? Compared to navigating without ECDIS, would you say that ECDIS:

___☐ greatly decreases your navigation workload → why?
___☐ slightly decreases your navigation workload → why?
___☐ neither decreases nor increases your workload
___☐ slightly increases your navigation workload → why?
___☐ greatly increases your navigation workload → why?
___☐ n/a--don't use ECDIS

What do you like best about ECDIS?

What do you like least about ECDIS?

Data Transmission with OIS

*The next set of questions deals with using OIS to send and receive case information compared to using the radio.*

How do you transmit and receive case information to and from the station or group?

- ___☐ Almost all information is transmitted and received via OIS.
- ___☐ Some info is via OIS, and some info is via radio. ↓
  ___☐% via OIS; ___☐% via radio
  What types of info are sent via OIS vs. radio?
- ___☐ Almost all info is via radio → why don't you use OIS?

How does OIS affect the *time* it takes you to transmit and receive case information (to and from the station or group)? Compared with using the radio, would you say that information transmission time with OIS is:

- ___☐ much slower than using the radio → why?
- ___☐ a little slower than using the radio → why?
- ___☐ about the same as using the radio
- ___☐ a little faster than using the radio
- ___☐ much faster than using the radio

How does OIS affect the *currency* of the information you receive (that is, do you feel OIS enables you to keep more up-to-date on case progress)? Compared to using the radio, would you say that information currency with OIS is:

- ___☐ much worse (less up-to-date) than with the radio → why?
- ___☐ a little worse than with the radio → why?
- ___☐ about the same as with the radio
- ___☐ a little better (more up-to-date) than with the radio
- ___☐ much better than with the radio

How does OIS affect the *accuracy* of the case data you receive from the station/group/other units? Compared with using the radio, would you say that information accuracy with OIS is:

- ___☐ much more accurate than with the radio

___ ☐ a little more accurate than with the radio
___ ☐ about the same accuracy as with the radio
___ ☐ a little less accurate than with the radio → why?
___ ☐ much less accurate than with the radio → why?

How does using OIS for transmitting/receiving information affect your workload (that is, the time and effort you devote to information transfer)? Compared to using the radio, would you say that with OIS:

___ ☐ your workload is much greater than with the radio → why?
___ ☐ your workload is a little greater than with the radio → why?
___ ☐ your workload is about the same as with the radio
___ ☐ your workload is a little less than with the radio
___ ☐ your workload is much less than with the radio

Is there anything else you'd like to tell us about the use of OIS for transmitting and receiving case information?

# APPENDIX B: TECHNICAL EVALUATION OF TESTBED SYSTEM

This section provides a detailed technical assessment of the Phase One testbed system. It points out "features" of the testbed system which caused problems during the testbed, or were design compromises due to time and money constraints. It draws on these and the experiences of the testbed to make recommendations for future development of OIS.

## DATA MODEL AND PHYSICAL DATABASE DESIGN

### Unique Keys

Unique record keys were based on data values, including OPFAC and Resource ID. If those values changed, the unique key changed. If all related records in other tables were not updated, the links would be lost. Yet these links are what give relational databases power. Generating a data independent unique key alleviates this problem. Possible key values can be generated from date-time stamps or hashing original data values.

The OIS Phase I testbed system allowed the user to input the vessel name on the notification screen, but then used this as a part of the 'Situation Name,' a nickname that could not be changed. This meant the user could never change the Situation Name, even if information was updated. This made it very hard to find information later. The reason for the inability to update was that this was a key value. Future versions should ensure that all keys are values that the user will have no need to update, and allow updating of all values. Vessel Name, and Person First and Last Name both suffer from this problem in Phase I.

### Coast Guard-wide Cross Functional Data Management

In the Phase I OIS testbed system, the shoreside system schema contained values for both Estimated Length and Actual Length. LEIS II has an Actual Length value in the VslInfo table, and Estimated Length value in the Sighting table. The OIS Phase I Pen application has only one value for length, and a check box indicating whether this is Estimated or Actual. But this scheme does not support the information required by the legacy system. All modules of OIS should support separate values for Estimated and Actual Length.

In the OIS Phase I testbed system, Non-Coast Guard Resource handling was clumsy. This is partly due to a lack of detailed design work in this area, and partly because of differences in the way non-CG Resources are handled in SARMIS and LEIS II. Details are described below. One big lesson embodied here is that no matter what the mission (SAR, LE, MEP, RBS, ....) the USCG relies on and cooperates with external resources frequently. OIS needs a consistent, logical model for tracking our involvement with them and for identifying their capabilities quickly and easily in time of need. This includes the Excom capabilities in Phase I, Facility information in MSIS and SPEARS, and could potentially include other-agency ELT resources (check with G-OLE on this). Now for the detailed problems of Phase I: The non-CG Resource Screen allows

creation of sorties that contain conflicting descriptive info, and does not contain the proper SARMIS picklist for non-CG resource type. First, the conflicting descriptions: A non-CG Resource is identified by a CG OPFAC number and by a user-definable name. However, the subscreen currently allows the user to describe this single resource as being from the USCG Auxiliary, and the USCG Reserve, and an AMVER vessel, and another government agency, all at once. These various descriptors are in fact mutually exclusive. We need a way to preclude the user from entering illogical descriptions of the non-CG resource. The best way may be to disable all descriptive sections of the non-CG Resource window until the user selects resource type, then enable the frame that corresponds to the resource type chosen. This will increase accuracy and cut down on user confusion. Another issue relates to picklists. The third frame on the non-CG Resource Screen contains three picklists: Agency Type; Other Agency; and Agency Organization. These are all from LEIS II. There is another important picklist from SARMIS, which also specifies ownership of the assisting non-CG resource. It can be found in paper on page C-13 of the Red Book, COMDTINST M5230.10A, but that version of the list is out-of-date. For the actual list, use the one found in the code for SARMIS/DES version 2.0. Obviously, we should also display only the appropriate picklist for a given sortie. If the sortie Primary Mission is SAR, display the SAR picklist. If the sortie Primary Mission is ELT, display the ELT picklists.

The OIS Phase I testbed system was originally designed to generate the SARMIS Assistance Request Number (ARN) automatically, with no need for the user to track ARNs. But we quickly found that since the application provided no way to tell whether a SARMIS report had been generated for this case before or not, it was impossible to feasibly implement this since SARMIS/DSS requires an unbroken stream of sequential ARNs from each OPFAC. Therefore, we added the field ARN to the user interface and had users manually populate it. We did not add boarding numbers. This experience points up that for the length of time OIS must continue to populate legacy systems, it must be sure it can support all of their rules. But since we spend so much time tracking ARNs in the current SARMIS system and in the Phase I OIS testbed system, it is a very important goal to design future versions of OIS so that they eliminate time-consuming tracking requirements. Ideally, this would be accomplished by integrating the information requirements of all the legacy systems in a single central database.

During the OIS Phase I testbed system, we tried to integrate data fields between the various systems as much as possible. For instance, there are three different lists of Vessel Types in use in the systems OIS supports: LEIS II uses a 45-item picklist called Vessel Type, SARMIS uses a 16-item list called Vessel Usage, and the 4100 Boarding Report has a field called Use. OIS was designed to derive this value from the Law Enforcement Vessel Type, according to a rule base that said 'all ferries (LEIS II code, MFY) are Commercial Use,' etc. This turned out not to be a good place to derive, however, since the Use field is actually a very different thing than Vessel Type. Circumstances arose in which the Owner's use of a vessel did not match our prescribed list. For instance, Station New London boarded a 22 foot outboard boat and called it a Runabout, which was true. So OIS classified this as a Pleasure boat. But it was actually being used as a ferry for hire to transport people to their boats at mooring buoys in the harbor. OIS provided no way to override this.

During the Phase I OIS testbed system, the pen application offered two Vessel Propulsion fields (for SARMIS and the 4100), while the shore application and schema offered only one (SARMIS). This prevented the shore application from being able to print appropriate values for propulsion from the shore system. In order to fix this, we integrated the picklists and used only one integrated picklist on each platform. We removed the SARMIS picklist from the pen application, and changed the label on the other one to simply 'Propulsion Type,' removing the parenthetical '(LE).' We used the 4100 list as the integrated picklist. We also added an eighth value, 'Other.' When generating the Boarding Report from pen and from shore, we displayed the word value, not just the integer which served as the picklist index. For LEIS II export, we sent the word value from this list. For SARMIS export, we mapped the value in this list to a corresponding value in the SARMIS list, using the following rules:

| 4100 list: | SARMIS list: |
|---|---|
| 1-Outboard | 01-Power-Driven |
| 2-Inboard Gas | 01-Power-Driven |
| 3-Inboard Diesel | 01-Power-Driven |
| 4-Inboard/Outboard | 01-Power-Driven |
| 5-Jet Drive | 01-Power-Driven |
| 6-Sail Only | 04-Sail |
| 7-Manual | 06-Manually Propelled |
| 8-Other (spec) | 02-N/A |

This whole situation highlights the need for better integration between our field systems, via a single integrated central database. There is currently a Data Administrator billet in Headquarters, but the office carries no authority to mandate compliance, and the personnel are normally tasked with other collateral duties. Until the Coast Guard addresses this problem, we will continue to have data interoperability problems.

The Coast Guard's data element naming standards must be enhanced, then used. There are many systems in the Coast Guard which share common data elements. However, many are named differently, have different formats, even different data types. This makes it very difficult to build new systems, or to aggregate data for corporate Executive Support Systems.

**Enhancements**

Add a Track History Log to the Shoreside System so that all OIS position files are logged, and can be subsequently recalled and displayed as tracklines with labeled waypoints. The search algorithm for these should allow the user to specify a date/time range or a lat/long bounded box, and display the results. It should also allow the user to search for Resource Events (sorties)which contain waypoints meeting the criteria by sortie identifiers such as distressed vessel name, Boarding Number, Unit Case Number, etc.

In early versions of the OIS Phase I testbed system, the mobile and shoreside applications did not send position narratives back and forth. They also did not send remarks fields, and the shore could not send chrono notes to the pen. The net result was that there was not a single free-text data field or remarks field in the whole application that could be sent between mobile and shoreside systems. The position narrative field was made two-way capable as a workaround.

Future versions should ensure that chrono notes can be sent to and from all systems. Also, remarks fields should correspond between all modules of the application. Another set of fields that does not get transmitted from on shore to pen is in the SAR Summary table. A few fields can be sent from pen to shore: Cause of Incident; Body of Water; and Actual Severity. This imbalance confuses users, and has the potential to cause data conflicts.

The Phase I OIS testbed system had to impose a slight change on several picklists, by adding a 'None' or 'Not Applicable' choice. Sortie SAR info: Rescue Equipment Used; Personnel, Property & Comms Assistance Rendered; Sortie Abort Reason, Locating Equipment Problems, Rescue Equipment Problems, Comms Problems, Miscellaneous Problems, Reason Search Suspended. Situation SAR Info: Body of Water, Cause of Incident. The ability to enter a null choice is supported in these fields in SARMIS/DES, since it allows the user to skip them without making a choice; but the mechanism is slightly different.

The OIS Phase I testbed system did not have a feature allowing the user to 'merge' two Situations. This feature was needed badly by users in the testbed system, since many times both the Group and a Station would begin data entry on a case early in its prosecution. Once the nature and urgency of the case became apparent, one or the other would assume responsibility. However, there was no way for the unit which took responsibility to merge or import the data which had been entered by the other, so users would have to manually re-enter the data. This was compounded by the fact that OIS checks the InitialOPFAC field in order to assign responsibility for SAR case reporting. But in fact, initial OPFAC may only have been involved tangentially. At the Situation level in the schema, responsibility is indicated by the SMC OPFAC.

Users need to be able to track the history of who was SMC during a SAR case. For this reason, the OIS schema needs to be expanded to include unit level information. It currently only shows Situation level info (multi-unit, multi-mission) and Resource level info. OPFAC level is also needed, since SARMIS asks which unit was first notified (i.e., InitialOPFAC), and also which unit is 'claiming' this case for SARMIS reporting purposes.

The OIS Phase I testbed system offered limited support for describing non-CG Resources, in two separate places: The non-CG Resource subscreen from the Sortie Screen, and the 'Excom' database. Early Phase II testbed systems replaced the Excom database with a 'Facilities' feature, which is more flexible and fully describes that the resource may not just be a SAR Excom resource. This feature must be expanded in future versions, allowing description of resource capabilities, current position and ops, and even an RDSS feature allowing us to track them (many would desire this), if they desired, via DSC or some other open-standard RDSS implementation. The resource section should also provide access to the facility information in MSIS.

The Phase I Shoreside System allowed users to enter comments about the system. The system entered the user's login name and the name of the screen from which the comment was, and then wrote those items to an ASCII text file. These comments proved invaluable for feedback, but were difficult to manipulate. Add a date/time stamp, and store the comments in a table in the database for easier manipulation.

The OIS Phase I database schema does not support unit (OPFAC)-level information, such as ARN, Boarding Number, etc. You can store information at the Situation (multi-OPFAC) level, and at the Sortie (inside one OPFAC) level, but not for the OPFAC. In a fully-developed OIS, sequential numbers will not be needed, but there will still be a need an OPFAC-level table. One field not supported for this reason in Phase I is Personnel Resource Time.

OIS systems that are shared by more than one OPFAC (i.e. GruLIS and StaNH) present interesting challenges. There must be a mechanism for identifying which OPFAC the machine is supporting at Situation Create Time, and at Report Generate Time. Also, OIS must handle cases that evolve from a single unit to a multi-unit case. Further, it must allow for initial information on a Situation to be received by one OPFAC and entered into the system, but then the case prosecution and 'claiming' to be credited to another OPFAC.

Early versions of the Phase I OIS testbed system included all Group units as SMC candidates in the Situation SAR Info Screen - SMC OPFAC Picklist. However, since Stations cannot be designated as SMC for multi-unit SAR cases, this was invalid. The testbed system therefore limited the SMC picklist to Groups and above. This must be carried forward in future versions. More importantly, OIS must support the ability to pass the SMC designation from one unit to another at multiple points during a SAR case. It must record not only the final designation of SMC, but dates and times at which SMC designations were passed. This is critical case documentation.

Early in the Phase I testbed system, we transmitted copies of the entire CG Resource table with each datagram. A significant challenge for the CG-wide implementation of OIS is to define the rules by which OIS tracks the Coast Guard's dynamically changing resource structure. This will require tracking OPFACs and resource IDs (Hull numbers and tail numbers, and perhaps personnel ID and motor vehicle ID). For each Resource, OIS must know its permanent OPFAC, and any temporary assignment (as in the case where an AirSta help deploys aboard a cutter). For each temporary and permanent assignment, OIS and Aops will need to know the time arrived and departed that unit. The same info needs apply to each OPFAC, and its ADCON and OPCON. In conjunction with this effort, OIS must define rules for how it will make resource information available to command centers, operational planning staffs, support managers, and other entities. Managing our rapidly changing resource picture is critical to effectiveness, but complicated because the information is protected at various different levels and widespread geographically.

During the Phase I OIS testbed system, the LEIS II Validation routine sometimes reported that 'There is no Vessel record for this Sighting/Boarding.' What turned out to be happening is that because of a misspelling in the Vessel Name on either the Boarding Screen or the Vessel Screen, OIS couldn't find a matching Vessel record. We modified the message to read: 'OIS cannot identify a vessel which was the subject of the Sighting/Boarding. This may be because there is no vessel in the database, or it may be because of a Vessel Name mismatch. If there is a Vessel shown in your database, be sure its name exactly matches the names shown on the Sighting and Boarding Screens.' This highlights the need to make sure the relationships between tables are implemented in a robust fashion. Here, OIS relied on the user typing the Vessel Name into three different fields (Vessel screen, Sighting Screen, and Boarding Screen) exactly the same each time. The pen application solved this on the Boarding screen by dynamically building a picklist of all

Vessel records involved in the Situation and allowing the user to choose. Future versions must handle this in an easy-to-use, robust way.

The Person Screens (both pen and shore) allow you to specify people's roles in Situations. The Vessel screen allows you to specify the name of the owner and of the operator. But neither updates the other. When a person is identified as owner or operator, that information should be copied to the vessel screen. Conversely, when you add an owner or operator name on the vessel screen, it should update the person screen.

In the OIS Phase I testbed system, the pen application allows multiple violations of the same violation type. The shore system does not. For 4100 violations, there should only be one instance of each violation. For SABR violations, however, there may be many violations of the same type. This is a design issue which will require an improvement of the way violations are handled.

Person Info Enhancements: Data elements are not always grouped logically according to the user's world. In the case of Vessel info, the following are most commonly used and therefore belong on the main screen: Hull Color, Superstructure Color, Length and Estimated Length, Vessel Type (LE specific),Vessel Usage (SAR), State Registration Number, Document Number, Flag, Hailing Port, Propulsion (SAR). Other fields can be on the appropriate subscreens. Also, a logical tab order is important.

The OIS Phase I testbed system needed a way to tell whether or not a field was null. The design chosen included using a value of '-1' to represent null. However, the application code then had to explicitly handle this in all fields in all circumstances. This caused problems when some of the external system interface code simply took values from the database without checking, then inserted a negative number into a character or positive integer field. Also, most of the user-readable reports printed these out without checking. Thus, each report had many -1 values, which cluttered the page and confused the user. Future versions need a way of handling null values, but it must be more consistently applied. Ideally, nulls should be recognized by the DBMS, so that the application doesn't have to implement its own logic.

The Phase I Shore and Mobile systems each handle Time CG Notified and Time Underway differently, and neither handles it well. The first problem is that the differences give rise to data conflicts. The second problem is that auto-filling the date and time can lead to errors in case and sorties times if users blithely accept the 'free' value. Instead of auto-filling these fields, put a 'NOW' button next to each DTG field that inserts the current time, but then lets you edit it if needed. This provides the best combination of speed and usability.

## General System Characteristics

### Data Distribution Architecture

The pen and shore systems differed drastically in their approaches to storing and transmitting data. The pen system used a separate ASCII text file to store data for each Resource Event, while the shore used a relational database manager. The data transfer was done via ASCII text

files, with parsers on each end. But since the parsers were in C and Visual Basic, respectively, they were maintained separately. This gave rise to inconsistencies unless configuration management was bullet proof. A much better approach is to use an RDDBMS and its embedded approach to distributing data. The biggest challenge to implementing this in OIS is the fact that that the server must be able to change dynamically from one Situation to the next, much like the SMC designation changes in SAR case prosecution. In CG-wide implementation, we may also want to employ some sort of hierarchical server scheme, to balance the benefits of a single central data repository (consistency, integrity, ease of updates) against the cost, time delay and load balancing problems of sending everything to a single server.

There are certain categories of data that are currently not transmitted from shore systems to mobile systems. This includes some items which are logical, such as Abstract of Operations data; these items are included in the data elements which exist in the shore schema but not in the pen schema. However, out of the data elements which are common to both pen and shore, some still cannot be transmitted from shore to pen. These are primarily resource event level items. For instance, Boarding data can be sent from pen to shore, but not back. The same occurs for all data related to resource events. The reason is that there was significant potential for errors resulting from one mobile unit getting a copy of a record from another mobile unit, updating it, and sending it back to shore. The challenge here is to define the rules whereby other units can get copies of a Situation, and what parts they may and may not update.

### Archiving, Retrieval, and Data Management Issues

The Phase I testbed system allows users to 'Archive' and 'DeArchive' Situations, but only by scrolling through a long list of Situation names, which are sometimes meaningless. Situation Management tools should incorporate the following features: (a) Allow users to reopen archived Situations either because new operational events have taken place regarding this Situation, for regenerating operational reports, or for information. They should be able to search for archived situations by vessel name, vessel doc number, vessel state number, person last name, OPFAC, SAR Unit Case Number, Boarding Number, Violation Type, LE Action Taken, or date range. (b) Implement an enhancement to automatically determine which reports are required for each situation and generate them all at once. Eliminate the time-consuming, manual step of generating each report, then logging in on the CG Standard Workstation to transfer it. (c) For this item, 'archiving' refers not to the classic definition of off-line storage, such as tape, but to an on-line disk-type storage media, where it will remain easily accessible by users but not a part of the current operational database of 'open' Situations. For performance reasons, it would be preferable to store 'archived' info in a separate copy of the Situation database, not the active copy. However, they should remain on-line (either at the local site or a central site) for 2 or 3 years, so that units can easily retrieve historical data for analysis.

The Phase One R&D testbed system did not handle archiving and retrieval well. There was a rudimentary archive mechanism. In conjunction with future work on the distributed data architecture, there must be design work done on case management. How long does the local unit retain a copy of complete records? Do they retain summary information even longer? Where are records stored permanently? How do field users and headquarters people access archived

records? What kinds of search tools will be available? An easy-to-use adhoc query capability is important. In keeping with the principles of distributed systems, the user should not need to be concerned with where the data resides; the system should make that chore transparent.

**System Administration**

The OIS Phase I testbed system had several system administration problems. Users were not separated into categories, with various levels of permission. Instead, all had read-write-execute access to most system files. Many system files were initially kept in a directory which also served as the repository for data to be exported. However, the application did not 'clean up' after itself by deleting these data files after their transfer to the CGSW, so administrators had to manually delete them. But they sometimes deleted system files as well. Further, the system generates validation files and conflict files which are never deleted. Finally, the application creates 4 log files in the /h/OIS/comms directory, and the Progress database log file, all of which grow rapidly under regular use. Production versions of OIS must trim these types of files regularly. This problem has surfaced in LEIS II, as well.

Updating software in the testbed was easy for shoreside systems, but difficult for pen-based systems. The pen-based systems were not accessible in system administrator mode over the wide area network, The shoreside systems were, however. The shoreside systems could be updated by an analyst over the network, saving substantial labor and travel costs. The pen computer, however, could only be updated in person by mailing disks or paying a site visit. The advantages of the remote capability were endless. Not just OIS, but all Coast Guard systems, will be able to benefit from this capability.

OIS Phase One required that all system management functions be completed within the UNIX shell. This limits system maintenance to experienced programmers or administrators. Many of the system management functions could be consolidated into a single application or module of OIS and executed through buttons or menu selections, similar to the way they are implemented in LEIS II. This will greatly reduce the amount of time required to perform system maintenance and cut down on the number of errors that occur during maintenance.

Early versions of the Phase I OIS testbed system required that an administrator manually start the Progress database servers after a reboot. They were later added to the startup script, in order to automate the process. For ease of maintenance, all routine functions such as this should be automated.

**Help Systems**

Neither the shoreside system nor the mobile system in the Phase I OIS testbed system incorporated any on-line help. They did not even display a brief message in the status bar, as most current applications do. In many cases, especially for data entry, the user interface design made functions intuitive despite this lack of help. However, in spots where the user needed a little prompting in order to accomplish a function, the application proved very difficult to use, despite extensive training and an outstanding User Manual. We even implemented a system of peer-level

experts who were intended to assist other users at their units. But they cannot be always available. The lesson learned is that although a help system costs time and money to develop, it will pay off many times over through the life of a system by decreasing training costs and by increasing the appropriate use of the system. Help systems should be context-sensitive, enabling you to get immediate help for the current data field or menu item. They should include rich sections of 'See Also' related topics. They should use hypertext jumps and popup concept definitions liberally. They should have large indices and search topics. They should incorporate status bar hint messages, preferably straight from the database schema where applicable. And they should employ 'balloon' hints like the current generation of new GUI products, where pointing to any screen object for more than a half-second pops up a small definition window. Help systems should include specific help for each individual field: what the field name means, what format data should be entered in, the range of values allowed, and special explanatory notes about the field. For instance, SARMIS has very detailed information about each data element in SARMIS/DES. This must all be captured in OIS.

### System Development

The OIS Phase I shoreside application contains many "memory leaks," in which memory is allocated but never deallocated. These exist mostly in the user interface code, which is C++ and X Windows, which are notorious for this problem. These leaks can cause sporadic, unpredictable application crashes. In future development, if the environment is known for such symptoms, it would be wise to purchase the specialized debugging tools which are available.

The size of the OIS database makes testing a lengthy, complex process. Newer development tools exist to automate a large part of the testing process. These would enhance development productivity tremendously.

## COMMUNICATIONS

OIS Phase One did not provide an informal electronic mail or messaging system between units and resources. This capability is an important coordination tool.

### Conflict Handling

The command center duty officer is primarily an information broker. The duty officer needs OIS to provide tools to help sort through the large amount of data coming in, and cut to the meat of the Situation. Therefore, when new data is received by any OIS system, it should pre-process the data and turn it into information for the duty officer. Step 1 is to see whether this is a completely new Situation or not. If it is new, there will be no need for a Conflict Report. If it is not new, the system will need to check for conflicts and report them to the user. Step 2 is to notify the user with audible and visible alerts. Both must be noticeable yet not annoying, since the user may be busy and not want to be interrupted. Specifically, users have indicated that they don't want an individual message box alerting them to the arrival of each update, but it is important to be able to review updates and handle them individually. Therefore, there must be one button, like the one in the Phase I Menu Bar, which indicates the presence of new data. When the user clicks it, it

presents a list of all system updates that have not been viewed by the user. Each list entry must indicate whether or not there are any conflicts. They must be presented chronologically, and the system should not allow processing later updates to any Situation before earlier updates for that same Situation (check this with a user group). Clicking on a list entry must keep the list box open, and also present a “New Data Summary Report” (NDSR). This is Step 3. The NDSR must start with a summary section, which presents Situation ID, Location, and Situation Subject (i.e., distressed vessel or subject person); SMC; units involved; unit first notified; and a brief description of the Situation Subject. The second part of the NDSR will be a Conflict List, which lists each data element in the incoming data stream that conflicts with the value in the local database. This must be presented as a dynamically built list of data elements, organized by table. The presentation must include a fully understandable field label, then the two data values (local and incoming) (both presented in English, not as a code). The interface must present a simple single-click method of choosing whether to accept the local or incoming value. The third part consists of a summary listing of new data, similar to the conflict section except that since there is no incoming value, there's no need to present it or ask which value to accept. Finally, the NDSR should provide quick access to the situation summary report, perhaps by clicking a button on the NDSR, so the user can quickly scroll down to see other case facts while reviewing the new data. This is critical for putting the new information in the proper context.

The Phase I OIS testbed system handles incoming data safely, but not in a fashion that makes it easy for the user to sift through large amounts of information. One feature that protects data is called 'Conflict Reporting.' When incoming data contains a value that is different than the value in the local database, that value is not inserted into the local database, but flagged for user review. Early versions of the OIS testbed system contained 'negative reports' on data conflicts. For example, the data conflict report for the Vessel Equipment table lists about 15 fields, taking up nearly two screensful, then at the bottom says 'No conflicts encountered.' This detracts from the user's ability to quickly process the information OIS provides. Review of this and other reports has led to the general rule that a system for opcenter use should not give negative reports. However, there are exceptions, such as Ops Normal. A typical Ops Normal report is actually a negative report, saying 'No Trouble Here.' But we definitely want that to come through.

The Phase I testbed system performed conflict checking on system-generated fields as well as user-populated fields. Therefore, the user sometimes received notice of a conflicting data element, but had no way to update the data since there was no user interface field. Future versions must avoid conflict checking on any field which is not user-editable. There are other fields that should not be conflict-checked, such as resource position updates; we expect these to change, so can accept them as valid.

## Encryption

OIS Phase I incorporates DES-level encryption via software. All data sent external to one location, either via landline or cellular, is encrypted. This is an important feature to retain in future versions of OIS. The Phase One encryption capability is file-based: individual operating system files are encrypted and transmitted. The Phase Two system will rely on a distributed database manager to handle data distribution, removing the application’s need to perform that

function. But this also removes its ability to handle encryption at the file level. OIS will need to move to some form of byte stream encryption.

During the Phase I OIS testbed system, all data transmissions were encrypted using a software-based DES encryption module. The encryption modules were purchased off-the-shelf, and consisted of object code that our application could use simply by making function calls. The product was 'Secret Agent,' by Information Security Corporation. For the most part, it worked very reliably. However, datagrams were sometimes not decrypted by the receiving system, whether shore or mobile. One problem turned out to be that in the public key, we used a date-time stamp, but one end used a leading zero for hours while the other did not. After fixing that, however, the problem still surfaced in approximately two percent of transmissions (based on rough estimates from users).

**Remote Dependent Surveillance System**

OIS Phase I implements RDSS functionality in a proprietary fashion. The dGPS unit sends standard NMEA 0183 sentences, but the ECS package used, MapTech Pilot, reads them into a proprietary storage format. Phase I uses this format rather than NMEA 0183 as its position datagram format. Future releases should use NMEA 0183 sentences.

In the OIS Phase I testbed system, the USCG Resource table, which contained position information, was updated each time a datagram was sent. This conflicted with the current positions sent by the boats themselves. The conflicting records were coming from old Resource Event information. Resource Event info, which is historical, should never replace current position and ops information. But current position and ops should be easily updatable by the user. Also, OIS must allow the user to filter which resource types are displayed, and which Excom types (non-CG resources). These filters should work by resource type, geographical area, and CG organizational boundaries.

**Routing**

In early versions of the OIS Phase I testbed system, Situations which were initiated on the mobile system were not automatically sent to the parent OPFAC. Therefore, the station may not know what its boat is doing. This was corrected in later versions of the testbed system by autorouting to the parent OPFAC of the resource. Future versions of OIS must extend this by building a list of all OPFACS and Resources involved in each Situation, with both 'Action' and 'Info' addressees, and autorouting to each. Resource position and ops info is even more demanding, and not Situation-dependent. Each command center should have position and ops info on each resource under its command, and on each resource not under its command but within its AOR or within 100 miles of its boundaries. This information would be provided automatically to all units through the OPFAC/Resource portion of the distributed database. Resource CHOPs (Changes of Operational Commander) are very dynamic and will be vital to good resource management. To illustrate the problem, the following is the text of a PTR submitted during the Phase I testbed system. Manual methods cannot keep up with this in a production system: "Add the following

boats to the ResourceID picklists: For New London, opfac 0130630: 210531; For Eatons Neck, opfac 0130196: 210525."

### UTB Communications Server

The Phase I testbed system only supported one method of mobile-to-shore communications, via the Electronic Chart System computer on board the UTB. This provided store and forward message capability for the boat. It also made sure OPS NORMAL reports always got through, even when the pen-based computer was undocked, as during a boarding. but it dramatically limited the flexibility of the mobile computer; it could only be used in conjunction with the UTB. In future implementations of OIS, the Boarding Officer Module should allow comms from any location. This should be available either via standard CG data networks of the future, or via the 'least common denominator,' the Public Switched Telephone Network (including cellular). This will maximize the utility of our portable field worker infrastructure. The Group Commander saw many opportunities for using the pen-based computer as a completely portable unit, including vehicle-based harbor checks and COTP functions. The data capture functionality and comms functionality must be separable from the ECS and OPS NORMAL functionality. This separation was not done well in the Phase One system.

The comms server and pen-based computer were not well integrated, in that they provided almost no feedback to the user about status of communications. Several improvements are needed if future versions of OIS use this comms server approach. The functional requirements are very similar to those surrounding the arrival of new or conflicting information at shoreside systems, described elsewhere. The lack of feedback to small boat and shore users created great confusion concerning the status of transmitted messages. When the mobile computer connects to the dock, the small boat communications server should notify the user if there are messages from shore waiting to be downloaded and provide an update on the status of messages sent to the shore. The shore subsystem could receive update messages with each OPS NORMAL indicating whether or not the mobile computer has downloaded the pending messages.

### Communications Reliability

In the OIS Phase I testbed system, there was a very high incidence (estimated by GruLIS users at ten percent) of data transfers that failed because of 'bad datagrams' and 'unparseable records' reported by the shore and pen applications, respectively. This was the subject of extensive troubleshooting and rework, and was improved incrementally, but was never completely resolved. A design lesson for future versions is to make the various modules of OIS rely on a distributed database wherever possible, letting the DBMS product do the work of exporting and importing. If that is not possible, parsers should be written and maintained in a common language on the various platforms involved. The Phase I testbed system used a shoreside parser written in Progress 4GL, and a pen parser written in Visual Basic, so they had to be maintained separately. This resulted in extra developer workload and configuration management problems. The primary symptom was crashes in the Parser and/or the Pending database when transferring multi-line remarks fields. The root problem was that a Carriage Return-Line Feed character cannot be stored in a Progress DBMS field, and cannot be handled in a parser using Progress 4GL. The

application code was supposed to strip each CRLF and substitute an ASCII 255, but sometimes this failed.

During the OIS Phase I testbed system, data communications were very unreliable. In most circumstances, the comms failure was not even detected by the system and reported to the user. This caused users great frustration, and is completely unacceptable for a production system. The general lessons are that (a) comms must be reliable; (b) if comms fail for some reason, at any point along the way, users at both ends must be notified; (c) users do not want to see 'data successfully transferred' messages, since they assume that the message should get through. They only want to know about the occurrences that do not meet expectations. OIS needs to address this not just in the limited context of point-to-point messages, but from the context of a network of distributed databases, where a transaction must be rolled back if it cannot be completed at all sites. For OIS, we should actually allow transactions at every site that gets the data, but queue the failed transactions for committal to the off-line database as soon as it rejoins the network.

Because communication between remote platforms is a critical need in the system, communications have to be not only reliable and robust, but if problems arise, they need to be quickly diagnosed and resolved. The Phase One system relied on a "Queue Manager" for handling all communications-related tasks. It was a background process that the user did not normally need to be concerned with. However, when an exception or error condition occurred, the user had no tools to assist in diagnosing and resolving the problem. Future versions must have a module or application that provides a front end for managing such a queue and messages placed into the queue. Messages should be able to be added, deleted, delayed and prioritized. Also included would be a log that shows the history of messages and other communications between platforms. The log would show a message, its current status and what actions were taken on the message.

As a mission-critical application, OIS will require at least one alternate data communications path, and possibly more. During the testbed, the secondary means of communication was voice radio. As OIS is relied upon more and more, this would be unacceptable.

OIS Phase One Testbed relied on voice grade dial-up phone lines and modems for wide area networking. This was a high-maintenance, low-performance solution necessitated by problems in the network design. The use of more advanced transmission protocols, such as X.25, for high-speed wide-area networks would greatly reduce the data communication times and troubleshooting and directly reduce the overall system operation and maintenance costs.

## PEN-BASED APPLICATION

OIS Phase I includes a Validation module as part of the Shoreside System. The concept behind this approach is that operations watchstanders frequently do not know all details about a Situation while it is ongoing, and cannot afford to be locked out of any part of the application because of that lack of knowledge. Therefore, the OIS application allows you to create a Vessel record with as little as the vessel name, or a person record with only a last name and first name. However, the legacy systems which OIS feeds have more stringent requirements. So after a Situation has been handled, the user runs a Validation routine. This applies the business rules embedded in the

legacy systems to the OIS database and prints a report of the fields which still need to be filled in. This exists only on the Shoreside System in the Phase I testbed system. However, during LE boardings, the Boarding Officer needs a Validation Tool in the Pen-Based application. Since the OIS Boarding process consists of 12 to 15 screens, the BO needs a tool to track boarding progress. This would be run before the receipt is printed, ensuring that the boater gets a complete and accurate record of the boarding, and that the record sent to shore will be accurate also. We should also allow the user an override button here, though, in case there is some legitimate reason that we do not presently foresee that certain information is not available. G-OLE should also review this from a policy perspective: once a boarding is complete, we may want to disallow any edits of that boarding report, except for violation remarks.

The Phase I testbed system has no lat/lon or position narrative on the Boarding Screen. It used the position info entered on the Notification Screen, but that caused great confusion.

It can be useful at times for the boat crew to have a physical printout that summarizes the current mission or assignment. The Phase One mobile system acts only as a data entry device. To view data already input or received from shore, the user must page through several screens. Adding the ability to print a quick one page report that summarizes the data received so far on a situation would give a hard copy capability to the entire boat crew. A one page summary can be viewed quickly to get general information on the situation.

Early versions of the Phase I OIS testbed system pen application printed a message at the bottom of the receipt when there were no violations recorded during a boarding. It read, 'Congratulations! You have no violations!' This was deleted for the testbed system, but a similar feature may be desired by the program managers in future versions. Various messages could print out, depending on the number and nature of violations.

Early versions of the OIS Phase I testbed system Pen-Based Application had a clumsy save mechanism. The user was forced to explicitly tap a button to save data, instead of the application saving it automatically. Further, when a user saved, the application took about 20 seconds to unload the forms and save, then returned to the Notification Screen after completing the save, requiring that the user navigate manually back to the screen where they left off, which takes 10 to 30 seconds more. This obviously discouraged users from saving, not a desired effect. The update eliminated the form unloading, and reduced save time to less than one second. But future versions should save automatically every time a screen is opened or closed, as in the shoreside. Use of database transactions will help handle this.

Mobile personnel need a quick, easy way to load the current position. When the user taps the position button, the application should get the position from the navigation sensor, if connected, or from a local disk save file, if disconnected. The contact to the navigation sensor or ECS computer should be entirely invisible to the user.

**Violation Handling**

Handling of violations must be improved in future versions of both OIS and LEIS II, bringing them in synch with the complete range of regulations we enforce. LEIS II offers a tiered system

of violation description, but it is implemented somewhat clumsily, with overly detailed categories in some areas. It also does not sort citations into the various categories, although the framework exists to enable that capability. The OIS boarding officer application should present a list of regulatory categories, with subordinate lists of citations in each category. The application should include a remotely updatable expert system module which provides the boarding officer with a list of current requirements in each category, and the ability to point and click to select appropriate citations. It should also contain a checklist of documentary requirements for each citation or citation type. For instance, for a simple violation such as insufficient fire extinguishers, a brief comment a la the 4100 S would suffice. For more serious Action Taken, such as Termination, more detailed statements are required. For arrests and seizures, the boarding officer application should maintain chrono notes and evidentiary custody logging.

### Screen Navigation

The OIS Phase I testbed system provided very little help for the user in knowing how far along in the boarding process they were. This caused frustration, and users expressed a desire to have a 'real 4100 form' on the computer. Interviews revealed that what they really wanted was a better way of knowing where they were in the process, and quicker navigation between screens. One common suggestion was to have a single, scrollable screen form.

### Docking Station

The pen-based computer was initially installed aboard the UTBs in a docking station. However, the docking station did not integrate well into the workflow on the small boat. It was located on top of the chart table, the only flat surface in the wheelhouse of the UTB. To overcome this, it was designed with a Plexiglas cover, and was exactly the size of the original chart table. But you could still only use the chart table for one thing at a time. Also, it was difficult to see the computer screen since it was mounted flat. Finally, the connector design was awkward and flimsy. A better design would have the mobile computer mounted on an adjustable frame bolted to the bulkhead, similar to what is done in police cars. A detachable keyboard would be mounted on an independent, movable frame. There is not enough room in the existing UTB cabin for an adequate workplace, but users indicated it would not be a problem to have it mounted below, since use is not expected to be continuous over long periods of time. As ECS and a computer workstation are added to the electronics complement, however, there should be significant redesign of the entire console to better integrate the new components. Presently, the valuable space directly in front of the helm is taken up with gauges in an inefficient layout.

## SHORESIDE SYSTEM

### Graphical User Interface

Several of the windows (screens) in the Phase I shoreside system are 'modal,' indicating that until the user exits that window, all other windows are locked. However, the system allows these

modal windows to be hidden behind other windows. This is very confusing to the user, and does not adhere to GUI standards.

During complex cases or on busy operational days, the watchstander's screen can become cluttered with many windows and toolbars representing the different ongoing situations. The electronic chart quickly becomes obscured. Currently, it is possible for the user to hide all open windows and recall them quickly. This permits the watchstander to have a snapshot of the chart, but it is not possible to work with the chart frequently in this manner. A separate monitor for all charting functions, especially the SAR planning tool, is necessary to realize the full benefits of having an electronic chart. With the chart separate from the work area, multiple command center personnel can view the entire scene on the chart and have all of the situation's critical facts displayed simultaneously.

Chrono Notes and Sortie Events (Time Underway, On Scene, etc.) are on separate screens in the Phase I testbed system. But these two areas are where the watchstander spends the majority of time monitoring case progress. Also, the Sortie Times Screen was located three screens deep off a different screen from Chronos. Since Sortie Events are really a specialized case of Chronological Log entry, it makes sense to combine these. The Phase II testbed system has a different, more integrated approach that will also provide useful design feedback. One important improvement needed to the Phase I Chrono screen: It automatically timestamps the entry when you create it. But many entries are created time-late. The system must allow the date and time to be edited so that the entry reflects the actual time of the event. However, since paper log-keeping practices normally require time-late entries to be identified, this feature should be reviewed by G-N and G-O to see if they also want to retain the timestamp from when it was actually created.

In several screens, there are remarks and comment boxes which allow only two or three lines of text to be displayed at a time. This is usually insufficient. Five lines is a good number for most Remarks boxes.

Phase I Shoreside System users report that they spend the majority of their time in the sortie and chrono notes screens while prosecuting cases. This matches analysis of paper logs kept by command center watchstanders. Combine the Chrono and Sortie screens. Move the Sortie Times and Positions up from three screens deep to the first layer underneath sortie ID. The new combined screen will include two lists, like the current Chrono and Sortie lists, with a detail box for each that shows a summary of the currently selected item (like the Chrono screen works).

Person Info Enhancements: Data elements are not always grouped logically according to the user's world. In the case of Person info, the following are most commonly used and therefore belong on the main screen: Name (Last, First, Middle); Which Vessel (using a picklist built from vessels involved in this Situation); Gender, Height, Weight, Race; Role; and DOB. Other fields can be on the appropriate subscreens. Also, a logical tab order is important.

The Phase I Shoreside user interface user interface forces the user to explicitly deselect all items currently in a list before the 'Create' (or 'Add') button becomes enabled. Many new users never figure this out, and are unable to create new records because of it. Most GUIs don't implement

lists this way. Change future screens so that the 'Create' or 'Add' button is enabled even when another item is selected.

During the OIS Phase I testbed system, the shoreside system interface was updated by highlighting the labels of data fields that are normally mandatory in red. This helped users quickly locate them. Future versions should move these frequently-used fields to the top level in the application, and arrange them more logically on the screen and in the tab order.

The OIS Phase I shoreside testbed system allowed users to single-left-click on a chart object and display a single screen, such as the vessel screen for a vessel involved in a Situation. This could be enhanced greatly by using the object or property inspector concepts in new-generation GUI applications. For instance, the user could right-click an on-screen vessel icon and pop up a menu listing different information or update options: Show me all people associated with this vessel, the owner, its physical description, its SAR or LE or inspection history, etc.

The OIS Phase I shoreside GUI was rather primitive in terms of picklist behavior, tab order, etc. Future versions should adhere to GUI standards much more fully, and take advantage of some of the innovative concepts such as tabbed dialog boxes, right-clicking objects to get a menu specific to that object, and toolbars.

The OIS Phase I Shoreside System created a Vessel record by default at the start of every Situation. This was done with the intention of (a) creating a chart icon for the Situation and (b) having the icon represent the distressed vessel. This proved problematic, because ten or twenty percent of incidents either don't involve a vessel, or don't involve a vessel about which facts are known. OIS definitely needs a chart icon representing each case, but it should represent the Situation, not the vessel involved. Clicking on the icon should bring up a Situation Summary Screen, indicating the missions(s), incident type(s), a list of sorties (resource events), and a list of Chrono notes.

## Data Entry

Only a minimal amount of range and type checking is performed by the data entry applications in GRU/STA OIS. Additionally, many of the data elements used by external information systems have restrictions placed on them based on other data values. The current logic waits until a case is validated before alerting the user. This design was chosen in the interest of making sure OIS never disallowed a user from going down a certain path because of embedded rules. Future work should embed more intelligence in the data entry applications, rolling some of the validation logic forward in time. Some things may need to remain at the end of the process, but in keeping with user interface design principles, as much checking as possible should be done as early as possible in the process.

The data entry forms used on the Shoreside subsystem are organized by topic and as a result, the watchstander was frequently required to navigate through several screens in order to find a certain data element. To make the system easier to use, many of the data elements should be enterable in two different ways. The first would be a general data entry screen where information common to most incident types is recorded along with a text field for a detailed narration and log

entry. If any information is gathered at the onset of the situation that cannot be entered into one of the common fields, it would be recorded into the narration field. At a later time, the data could be selected, then "dragged and dropped" into the appropriate data entry fields. The second method of data entry would continue to have the fields grouped by subject, (i.e. vessel, person, resource), but have the user interface guide the watchstander, using the "smart checklist" concept. The application would guide the user through required and optional items. It would also present questions for the watchstander to ask people on scene to ensure as much required information as possible is gathered when it is available.

### Resource Management

OIS must allow the user to designate many types of resources, including both Coast Guard and non-Coast Guard. The traditional Coast Guard resources, including cutters, Standard Boats, and aircraft, must be included along with the wide range of non-standard boats vehicles, personnel sorties, and other Coast Guard resources. External systems impact this: SARMIS tracks information about Auxiliary, Reserve, and AMVER vessels. Both SARMIS and LEIS II track information about other federal agency involvement, state and local agencies, and foreign governments.

### Queries and Reports

The Phase I Situation Summary Report is unwieldy. It takes several pages to print, and dumps the data from a table in a single column with no formatting for ease of reading/interpretation. The report should be designed with watchstander input to organize it into easily digested sections of information. It should include Chrono Notes and Sortie Time in an interspersed chronological format, as they are in the Phase I SITREP. The reports in LEIS II are a useful starting point, since they contain much of the same information.

A very time consuming task for the watchstander is conducting Precom and Excom phone calls. The OIS database contains phone numbers of local marinas, police stations, hospitals and other Excom sites. To facilitate these procedures, the watchstander could select sites to contact and have the OIS hardware dial each of them. The system would then either fax a request for information, send information on the situation, or connect the watchstander by voice to the site. An auto-fax capability would be very helpful. In addition to the auto-dial tools, the watchstander needs powerful query and report tools. These must allow you to search by geographic areas, lat/long boundaries, facility types, and trackline. The resultant report would include some form of tracking mechanism so the database would know who has been contacted and what the results were.

## Validation and Reports

### External Systems

Early versions of the OIS Phase I testbed system built a fixed-size array to hold data for generating external reports. In some cases, the size of this array was only 50 records. So when

the unit conducted its fifty-first LE boarding, the Report Controller gave an error message 'array subscript 53 out of range' while the system was building list of situations to choose from. By the end of summer, Group LIS had over 1,000 situations in the DB. For the testbed system, the fixed limit was simply made larger. Future versions must not impose any fixed limit.

There is no indication in Gru/Sta OIS of whether or not a set of case data has been exported to the necessary external information systems. OIS should include an indication of which external systems have been updated from this situation, when they were updated and whether the situation has been modified since the update.

Early versions of the Phase I OIS pen-based application had an error in the way they built data files, which resulted in LEIS II export errors. When the pen application created a Sighting, it also automatically created an empty Boarding record. Then the shoreside Validation routine found a Boarding record, and required the user to enter the rest of the Boarding data, even though one was not really performed.

The OIS Phase I testbed system suffered a large number of schedule delays and errors related directly to external system interfaces. The design team did not analyze the requirements of the external systems adequately, and therefore were unprepared for implementing the interface. This is not a new lesson in the industry, but is worth restating here. Interfaces, especially with older systems, constitute some of the biggest challenges facing application developers.

The OIS Phase I shoreside system required the user to describe a Sortie by choosing a Sortie Type, an OPFAC, and a Resource ID. In addition, for each Sortie where the Primary Mission was SAR, the user had to select Resource Type. However, this could easily be generated by the system for CG resources, since the user just filled in the Resource ID.

The Phase I OIS testbed system learned an important lesson about applying the business rules embodied in external systems such as LEIS II and SARMIS. In several instances, those systems have rules requiring that a certain field be null. When this is the case, do not force the user to delete the value. Export a null value to the external system, but allow the user-entered value to remain in the OIS database. There are several individual data elements that fit this category. Another excellent example that was not fixed during Phase I is the entire person record. LEIS II requires that if a person record is created, it contain at least nine data fields. In many cases, however, OIS users wanted to create a person record to track limited information about a person with limited involvement. The blanket imposition of the LEIS II mandatory fields discouraged this, however, and users learned to avoid putting person records into the system unless they had to. A good fix for this would be to build a list of people at Validate time, with a set of check boxes next to each record indicating whether or not it should be exported to the various external systems. This same concept applies to vessel records for SARMIS.

In early versions of the OIS Phase I testbed system, the concept of a Communications Sortie did not exist. In Release 1.0, the system was updated to include Comms Sorties as an explicit Resource Event Type on the Sortie Info Screen. This concept made the SARMIS export much more explicit and straightforward. It will also have value for other mission areas.

The OIS Phase I testbed system did not handle multi-unit SAR case reporting to SARMIS correctly. In a multi-unit case, SARMIS/DSS requires a Unit Report for each GLIS OPFAC that was involved, including the SMC. Unit Reports for multi-unit cases have A, C, and D records, but not B records. The B record of each Unit Report in a multi-unit case is filled with a pound sign (#). The A record for each OPFACs Unit Report contains three critically important differentiators that are keys for SARMIS/DSS and SAR mainframe: the unit OPFAC, the unit's ARM, and the MUCNO. In addition to these Unit Reports, SARMIS/DSS requires exactly one SMC Report for each multi-unit case. The SMC Report consists of only an A record and a B record. It has no C/D records, not even the C/D record representing the Personnel Resource Time. That is credited to the SMC's report. The OIS Phase I reports are incorrect. This will need fixing for Phase II, for the interface to DSS. In the long term, the future upgrade of SARMIS should adopt a scheme like the OIS Situation DB, which handles multi-unit information better.

The OIS Phase I testbed system pen application recorded a separate LE Action Taken for each Violation reported. On the actual form CG-4100, however, there is only a single LE Action Taken code for each boarding, not one per violation. For future versions that support Boardings, developers should consult with G-OLE, G-CJ, G-NAB, G-LMI, and other interested divisions to determine whether or not they want to change the granularity.

In the Phase I OIS testbed system, the database definition for the field Violation Remarks is limited to 1024 characters. This is insufficient. It should be an unlimited memo field. Also, the pen and shore handle Violation Remarks differently. The pen groups all Remarks together, rather than separating them one per Violation. The shore, however, associates one Remark with each Violation record, as you would expect. This resulted in all Remarks from the pen coming ashore as a group, and being inserted into only one of the Violation Remarks, not all. There is a workaround which makes the Remarks read-only on shore, requires all remarks to be entered on the pen, and prints out only one set of Violation Remarks on the Boarding Report and for LEIS II. This is obviously fraught with problems, and needs rework in future versions.

Early versions of the OIS Phase I testbed system did not export State Registration Number to SARMIS/DSS. The DSS database accepts either document number or registration number, whichever is populated. This is theoretically never a conflict, since vessels are supposed to be either registered or documented, but not both. The DSS export routine was enhanced to export whichever of these is populated. If both have values, OIS sends the document number.

In early versions of the OIS Phase I testbed system, the SITREP did not include Sortie dates and times. The report was updated to include, for each sortie, all Sortie Times that were populated, but not null ones. These included Date/Time Underway, Began Searching, Ended Search, On Scene, Departed Scene, and Sortie Ended. For LE, include Sighting Date/Time, Boarding Start Date/Time, and Boarding End Date/Time. These date/times are reported in paragraph 2 of the SITREP, Action Taken, along with Chrono Notes. The complete set of Times and Notes are sorted in chronological order. In future versions, this feature must be carried forward. It should also be enhanced by converting all alpha characters in Chrono Notes fields to upper case. The times/chronos subreport should also be copied into the Situation Summary Report, since it is one of the critical pieces of information for users.

In the Phase I OIS testbed system, the external reports generator module does not check the OIS data for validity against the external system format before exporting it. This results in export errors. The OIS database definition almost always defines fields to be exactly the same format as their intended target. However, the Progress database engine allows the OIS user interface to insert values via ESQL that do not match the format defined in the schema. Future versions must resolve this, preferably by using a database engine that enforces format constraints. If that is not feasible, the application must check export formats carefully to avoid sending invalid values.

The OIS Phase I testbed system LEIS II transfer module exports a question mark for POB birthdate under some circumstances. It appears to happen only when the person in question is the owner. An Owner Not On Board record is handled separately from other people records on the pen application. For most people records, the shoreside Validation routine requires POB birthdate, but skips it for records where the Role equals 'Owner.' This must be fixed in future versions that support Boardings.

The OIS Phase I testbed system had a misconception in the way it built its LEIS II transfer files. It generated a record for the LEIS II 'CASCONEG' table for each boarding or sighting. This is not appropriate, since LEIS II actually uses the CASCONEG table to track groupings of sightings and/or boardings into a logical 'case'. In fact, a CASCONEG record indicates the equivalent of a multi-unit case for SARMIS purposes. CASCONEG records are created manually by intelligence officers in the district offices. The Phase I OIS testbed system is only capable of generating single-unit event records, so it should never generate a CASCONEG record. During the testbed, the CGSW import code was modified so that it did not actually create a CASCONEG record in the database, but it still used the "case.exp' file as a cornerstone of building the OIS export records. This makes sense, since OIS is inherently a multi-unit, multi-mission system. However, its usability was limited because although the schema supports links between multiple vessels, the people on each vessel, and potentially multiple sightings or boardings of each vessel, the application code did not follow those links and generate boarding records accurately if there were more than one vessel involved in a Situation. Instead, the application code simply used a Progress 'FIND FIRST Vessel' statement to find a vessel record matching the Situation key, but did not check to see if it was the vessel recorded as the subject of the boarding in the Boarding table. As a testbed system workaround, it was agreed that the easiest short term solution would be to add a new Validation rule which checked to see if this Situation involved one of the ELT mission areas, then checked the number of vessels involved. If the Situation involved ELT, then the Validation rule required that you only have a single Vessel record. This is completely contrary to the OIS concept, however, and should be modified in future versions. Situations which involve multiple sightings and/or boardings are then inherently LEIS II 'Cases', requiring an LEIS II CASCONEG record.

The OIS Phase I testbed system contained a flaw in its generation of the LEIS II transfer file, related to the Assist table. OIS sometimes generated an ASSIST record for an LEIS II boarding record even when there was no assisting unit according to LEIS II rules. Rather, there may have been two OIS resource events because this was an after-SAR boarding, or involved some other resource event. This does not constitute assistance by LEIS II standards. LEIS II assistance records are created when other CG OPFACS, or other agencies, assist in the actual boarding. OIS

Phase 1 testbed system has no way to indicate this, so should not generate assistance records. Future versions should implement a means of supporting this LEIS II function.

In the Phase I OIS testbed system, OIS generated LEIS II transfer files inaccurately when there were multiple vessels involved. It generated a single Boarding record with two Vessel records associated with the same EventGroupID. Only one of them could have been the subject of a single boarding, however. If both were boarded, they should be exported as two separate boardings, with different Event Group ID numbers. This is similar to problems discussed in other redesign notes.

In the OIS Phase I testbed system, the database definition differed from the target system definition in terms of format for some fields. Social Security Number, Phone Number, and Zip Code are all commonly displayed with formatting characters including dashes and parentheses. The OIS pen and shoreside applications displayed them differently, and exported them differently to legacy systems. As a result, external systems sometimes received values like '444--5-5-66' for SSAN. Future versions must export values in the formats expected by the target systems.

The OIS Phase I testbed system LEIS II Export module exports a record for each person in the current Situation, without checking to see whether they were aboard the Boarded Vessel or not. This can result in invalid data being exported to LEIS II. Further, when OIS exports people records, it does not count them. Instead, it relies on the 'Number of POB' field in the Boarding table. Then, if the user completes four person records but enters a value of '1' in the 'Number of POB' field, LEIS II only displays the first person record. The others exist in the Local database but are not displayed, apparently because the numPOB value is less than the actual number of Person records. The Phase II testbed system will not address boardings, since the mobile system is intended for helicopter use only, but future versions that support boardings must count the number of person records and prompt the user to check numPOB if that value is less than the number of Person records associated with this Vessel during this Boarding.

In early versions of the OIS Phase I testbed system, Resource Events for one mission area were exported to the legacy systems for other mission areas. For instance, ELT boardings were exported to SARMIS. This resulted in very inaccurate records in the legacy systems. This was fixed by the end of the Phase I testbed system, but the concept must be extended as other mission areas are included in future versions of OIS.

The Phase I OIS testbed system has a field for Personnel Resource Time on the Situation -> SAR Info Screen. This value is exported into each resource event at SARMIS export time, because of the lack of an OPFAC-level table in the schema. Further, The value from the Situation -> SAR Info Screen should be exported into a SARMIS C/D record which is created only for Personnel Resource time. This particular C/D record is in addition to the C/D records which each correspond to an OIS Resource Event. Further, each SARMIS C/D record is allowed to contain a value for personnel time expended by people involved in this sortie. This is optional for each sortie, and never mandatory. OIS does not need a conditional; test on this, but does need a Personnel Resource Time field on the Sortie -> SAR Info Screen. This will go into a Resource Event level field in the OIS schema.

**Validation**

The Phase I OIS testbed system sometimes reported validation errors or conflicts on fields that the user could not update. This serves only to frustrate the user. This type of error should be trapped for and handled by the application.

During the Phase I OIS Testbed system, users were confused by some of the error messages. For instance, Validation Reports under some circumstances included the message 'the number of POB is less than zero,' with no further information nor instructions on how to correct the problem. This message is completely confusing: a negative number of POB? Only a computer could come up with that! All messages to users must be clear and specific. They should not only describe what problem has arisen, but more importantly, what the user can do to correct the problem. In this case, the message was changed to read, 'The Number of POB on the Situation Screen is blank, OR Total Lives Lost (Situation -> SAR Info Screen) is greater than Number of POB.' This was much more understandable, and cut down the number of trouble calls dramatically.

SARMIS Validation, Time Occurred: The OIS Phase I testbed system has no field in the shoreside system interface or in the database for 'Time Incident Occurred'. There is one on the pen and in SARMIS. The SARMIS export routine populated this field with the time of the creation of the first resource event. Since resource events are created after Notification Time, and Time Occurred is before Notification Time, this will always create an illogical time sequence. Add a field for Time Occurred (Could be placed on the Notification Screen, next to Initial Mission and Initial Incident Type). This must be user-updatable.

The OIS Phase I testbed system uses a complex series of IF-THEN-ELSE statements, frequently nested several layers deep, to implement the Validation rules derived from SARMIS and LEIS II. Future versions of OIS should use an expert system generator to allow easier maintenance. An even more important enhancement would be to implement the ability to update remote software sites over the network, with no user/administrator intervention at the remote end, so that program managers could change business rules reflected in the system more easily.

In some circumstances, data elements are legitimately unknown. For instance, in an overdue case, Reported Lat and Long are legitimately unknown because its last know position is imprecise. We relaxed the Validation rules affecting Reported Lat and Long from being mandatory to suggestive, using the statement 'If you know the Latitude and Longitude, please enter them on the Situation Screen'. This encouraged the user to fill them out if possible, but if suggestive items were the only ones encountered during a Validation run, they would not prevent the case from being described as Validated.

The OIS Phase I testbed system had a SARMIS Validation feature that felt clumsy to users. SARMIS requires a Reason Search Suspended. If any sortie conducted a search, the Validation Routine required a value in the Reason Search Suspended field. However, if the Search was actually successful, and the target was located, there was not really a suspension. Therefore, users felt that a sacred rule was being violated by having to put in a reason for suspending the search. Considering the gravity of a search suspension decision, this is completely understandable. Most of the picklist choices actually had to do with closing the case rather than

suspending anyway, but the field label caused concern for users. Future versions could relabel the field, or perhaps not require a value if any sortie says 'Located.' But it is more complex than this. One sortie can locate one of several search objects, but there are still other search targets missing, and the search could still be suspended. This needs more work.

Early versions of the OIS testbed system allowed successful Validation of a situation involving SAR where Primary Response was '4' (meaning CG active duty sorties were launched), but there were no records in the Resource Event table for that situation. This should not be possible. If priresp =4, then there must be at least one active duty SAR sortie associated with that situation. SARMIS has other Primary Response codes which should also be mapped to their corresponding Resource Event types. For instance, if Primary Response is 8 or 9, then there must be a Resource Event involving a non-CG Resource and/or a Comms Sortie. This concept is captured in the LE Validation rules: For each Situation where the Incident Type is an LE Sighting, there must be one and only one Sighting record. The same applies for Boardings. As OIS is extended to other missions, this concept must apply to the other mission areas as well.

# APPENDIX C: PHASE I AND II FUNCTIONAL DECOMPOSITION

This Appendix consists of a Functional Decomposition for the Phase One and Two Operational Information System. Several items contributed to this Functional Decomposition:

- The OIS Phase I design work and testbed system, as-built.
- The OIS Phase I business and technical evaluations.
- The OIS Phase II design work.
- The early phases of the work done by the Coast Guard's C4I and Sensors Team, G-OTT.

The Functional Decomposition was developed using the Function Point Workbench, an automated tool from Charismatek Software, Inc. It report output is inserted in the next nine pages.

# *HIERARCHY OUTLINE LIST*

USCG Operational Info System
FY97RCP

Application Development
Development Project

AC&I Development

**Level:** 0
**Component:** USCG Operational Info System
**Label ID:** NONE
**Option:** NONE
**Method:** All

## COMPONENT / TRANSACTION

1 Manage Resources
  1.1 USCGUnits (OPFACs)
    ***1.1.1 Create USCGUnit***
    ***1.1.2 Read USCGUnit***
    ***1.1.3 Update USCGUnit***
    ***1.1.4 Delete USCGUnit***
    ***1.1.5 Filter USCG Units***
    ***1.1.6 Display USCG Units List Rpt***
    ***1.1.7 Display USCG Units in GIS***
  1.2 USCGResources (incl Eqpt)
    ***1.2.1 Create USCGResource***
    ***1.2.2 Read USCGResource***
    ***1.2.3 Update USCGResource***
    ***1.2.4 Delete USCGResource***
    ***1.2.5 Filter USCG Resources***
    ***1.2.6 Display USCG Resource List Rpt***
    ***1.2.7 Display USCG Resource in GIS***
  1.3 OpCon Relationships (CHOPs)
    ***1.3.1 Create OpCon Relationship***
    ***1.3.2 Read OpCon Relationship***
    ***1.3.3 Update OpCon Relationship***
    ***1.3.4 Delete OpCon Relationship***
    ***1.3.5 Filter OpCon Relationships***
    ***1.3.6 Display OpCon Relations List***
    ***1.3.7 Display OpCon Relations in GIS***
  1.4 Non-CG Resources
    ***1.4.1 Create Non-CG Resource***
    ***1.4.2 Read Non-CG Resource***
    ***1.4.3 Update Non-CG Resource***
    ***1.4.4 Delete Non-CG Resource***
    ***1.4.5 Filter Non-USCG Resource***
    ***1.4.6 Display NonCG Resource ListRpt***
    ***1.4.7 Display NonCG Resources in GIS***
  1.5 Crewmembers
    ***1.5.1 Create Crewmember***
    ***1.5.2 Read Crewmember***
    ***1.5.3 Update Crewmember***
    ***1.5.4 Delete Crewmember***
    ***1.5.5 Filter Crewmembers***
    ***1.5.6 Display Crewmember List Rpt***
  1.6 Facilities
    ***1.6.1 Create Facility***
    ***1.6.2 Read Facility***
    ***1.6.3 Update Facility***
    ***1.6.4 Delete Facility***
    ***1.6.5 Filter Facilities***
    ***1.6.6 Display Facilities List Rpt***
    ***1.6.7 Display Facilities in GIS***

2 Manage Operations
  2.1 Monitor Environment
    2.1.1 Monitor OIS Resources
      2.1.1.1 Contained in Manage Resources

# *HIERARCHY OUTLINE LIST*

| | | |
|---|---|---|
| USCG Operational Info System<br>FY97RCP | Application Development<br>Development Project | AC&I Development |

**COMPONENT / TRANSACTION**

- 2.1.2 Monitor non-OIS Resources
  - 2.1.2.1 Contained in Manage Resources
- 2.1.3 Monitor SARSAT System
  - ***2.1.3.1 Receive SARSAT Alerts***
  - ***2.1.3.2 Create SARSAT Record***
  - ***2.1.3.3 Read SARSAT Record***
  - ***2.1.3.4 Delete SARSAT Record***
  - ***2.1.3.5 Filter SARSAT Records***
  - ***2.1.3.6 Display SARSAT List Report***
  - ***2.1.3.7 Display SARSAT Hits in GIS***
- 2.2 Receive & Process Information
  - 2.2.1 Notification Information
    - ***2.2.1.1 Create Notification Record***
    - ***2.2.1.2 Read Notification Record***
    - ***2.2.1.3 Update Notification Record***
    - ***2.2.1.4 Delete Notification Record***
    - ***2.2.1.5 Classify Notification as Case***
    - ***2.2.1.6 Classify Notification No Case***
    - ***2.2.1.7 Filter Notification Records***
    - ***2.2.1.8 Display Notification List Rpt***
    - ***2.2.1.9 Display Notifications in GIS***
    - ***2.2.1.10 Archive Notification Records***
    - ***2.2.1.11 DeArchive Notification Records***
  - 2.2.2 Target Information
    - 2.2.2.1 Vessel Information
      - ***2.2.2.1.1 Create Vessel Record***
      - ***2.2.2.1.2 Read Vessel Record***
      - ***2.2.2.1.3 Update Vessel Record***
      - ***2.2.2.1.4 Delete Vessel Record***
      - ***2.2.2.1.5 Filter Vessel Records***
      - ***2.2.2.1.6 Display Vessel List Report***
      - ***2.2.2.1.7 Display Vessel Records in GIS***
    - 2.2.2.2 Person Information
      - ***2.2.2.2.1 Create Person Record***
      - ***2.2.2.2.2 Read Person Record***
      - ***2.2.2.2.3 Update Person Record***
      - ***2.2.2.2.4 Delete Person Record***
      - ***2.2.2.2.5 Filter Person Records***
      - ***2.2.2.2.6 Display Person List Report***
      - ***2.2.2.2.7 Display Persons in GIS***
    - 2.2.2.3 Aircraft Info
      - ***2.2.2.3.1 Create Aircraft Record***
      - ***2.2.2.3.2 Read Aircraft Record***
      - ***2.2.2.3.3 Update Aircraft Record***
      - ***2.2.2.3.4 Delete Aircraft Record***
      - ***2.2.2.3.5 Filter Aircraft Records***
      - ***2.2.2.3.6 Display Aircraft List Report***
      - ***2.2.2.3.7 Display Aircraft in GIS***
    - 2.2.2.4 DMB Info
      - ***2.2.2.4.1 Create DMB Record***
      - ***2.2.2.4.2 Read DMB Record***
      - ***2.2.2.4.3 Update DMB Record***
      - ***2.2.2.4.4 Delete DMB Record***
      - ***2.2.2.4.5 Filter DMB Records***
      - ***2.2.2.4.6 Display DMB List Report***
      - ***2.2.2.4.7 Display DMB Records in GIS***
    - 2.2.2.5 CASP Target Info
      - ***2.2.2.5.1 Create CASP Target Record***
      - ***2.2.2.5.2 Read CASP Target Record***
      - ***2.2.2.5.3 Update CASP Target Record***
      - ***2.2.2.5.4 Delete CASP Target Record***
      - ***2.2.2.5.5 Filter CASP Target Records***

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## COMPONENT / TRANSACTION

2.2.2.5.6 *Display CASP Targets List Rpt*
2.2.2.5.7 *Display CASP Targets in GIS*
2.2.2.6 CASP Location Info
2.2.2.6.1 *Create CASP Location Record*
2.2.2.6.2 *Read CASP Location Record*
2.2.2.6.3 *Update CASP Location Record*
2.2.2.6.4 *Delete CASP Location Record*
2.2.2.6.5 *Filter CASP Location Record*
2.2.2.6.6 *Display CASP Location List Rpt*
2.2.2.6.7 *Display CASP Locations in GIS*
2.2.2.7 CASP Situation Info
2.2.2.7.1 *Create CASP Situation Record*
2.2.2.7.2 *Read CASP Situation Record*
2.2.2.7.3 *Update CASP Situation Record*
2.2.2.7.4 *Delete CASP Situation Record*
2.2.2.7.5 *Filter CASP Situation Record*
2.2.2.7.6 *Display CASP Situation ListRpt*
2.2.2.7.7 *Display CASP Situations in GIS*
2.2.3 Checklist/QRC Information
2.2.3.1 SAR Checklists
2.2.3.1.1 Ck: Vessel Taking Water
2.2.3.1.1.1 *Create Vsl TOW Rec*
2.2.3.1.1.2 *Read Vsl TOW Rec*
2.2.3.1.1.3 *Update Vsl TOW Rec*
2.2.3.1.1.4 *Delete Vsl TOW Rec*
2.2.3.1.2 Ck: Vessel Aground
2.2.3.1.2.1 *Create Vsl Aground Record*
2.2.3.1.2.2 *Read Vsl Aground Record*
2.2.3.1.2.3 *Update Vsl Aground Record*
2.2.3.1.2.4 *Delete Vsl Aground Record*
2.2.3.1.3 Cl: Vessel Capsized
2.2.3.1.3.1 *Create Vsl Capsized Record*
2.2.3.1.3.2 *Read Vsl Capsized Record*
2.2.3.1.3.3 *Update Vsl Capsized Record*
2.2.3.1.3.4 *Delete Vsl Capsized Record*
2.2.3.1.4 Ck: Vessel Disabled
2.2.3.1.4.1 *Create Vsl Disabled Record*
2.2.3.1.4.2 *Read Vsl Disabled Record*
2.2.3.1.4.3 *Update Vsl Disabled Record*
2.2.3.1.4.4 *Delete Vsl Disabled Record*
2.2.3.1.5 Ck: Vessel Becalmed
2.2.3.1.5.1 *Create Vsl Becalmed Record*
2.2.3.1.5.2 *Read Vsl Becalmed Record*
2.2.3.1.5.3 *Update Vsl Becalmed Record*
2.2.3.1.5.4 *Delete Vsl Becalmed Record*
2.2.3.1.6 Ck: Vessel Disoriented
2.2.3.1.6.1 *Create Vsl Disoriented Record*
2.2.3.1.6.2 *Read Vsl Disoriented Record*
2.2.3.1.6.3 *Update Vsl Disoriented Record*
2.2.3.1.6.4 *Delete Vsl Disoriented Record*
2.2.3.1.7 Ck: MEDEVAC
2.2.3.1.7.1 *Create MEDEVAC Record*
2.2.3.1.7.2 *Read MEDEVAC Record*
2.2.3.1.7.3 *Update MEDEVAC Record*
2.2.3.1.7.4 *Delete MEDEVAC Record*
2.2.3.1.8 Ck: MEDICO
2.2.3.1.8.1 *Create MEDICO Record*
2.2.3.1.8.2 *Read MEDICO Record*
2.2.3.1.8.3 *Update MEDICO Record*
2.2.3.1.8.4 *Delete MEDICO Record*
2.2.3.1.9 Ck: Flare Sighting
2.2.3.1.9.1 *Create Flare Sighting Record*

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- ***2.2.3.1.9.2 Read Flare Sighting Record***
- ***2.2.3.1.9.3 Update Flare Sighting Record***
- ***2.2.3.1.9.4 Delete Flare Sighting Record***
- 2.2.3.1.10 Ck: Vessel Overdue
  - ***2.2.3.1.10.1 Create Vsl Overdue Record***
  - ***2.2.3.1.10.2 Read Vsl Overdue Record***
  - ***2.2.3.1.10.3 Update Vsl Overdue Record***
  - ***2.2.3.1.10.4 Delete Vsl Overdue Record***
- 2.2.3.1.11 Ck: Aircraft Overdue
  - ***2.2.3.1.11.1 Create Acft Overdue Record***
  - ***2.2.3.1.11.2 Read Acft Overdue Record***
  - ***2.2.3.1.11.3 Update Acft Overdue Record***
  - ***2.2.3.1.11.4 Delete Acft Overdue Record***
- 2.2.3.1.12 Ck: Diver in Distress
  - ***2.2.3.1.12.1 Create Diver Distress Record***
  - ***2.2.3.1.12.2 Read Diver Distress Record***
  - ***2.2.3.1.12.3 Update Diver Distress Record***
  - ***2.2.3.1.12.4 Delete Diver Distress Record***
- 2.2.3.1.13 Ck: EPIRB Reports
  - ***2.2.3.1.13.1 Create EPIRB Reports***
  - ***2.2.3.1.13.2 Read EPIRB Reports***
  - ***2.2.3.1.13.3 Update EPIRB Reports***
  - ***2.2.3.1.13.4 Delete EPIRB Reports***
- 2.2.3.1.14 Ck: SARSAT Hit
  - ***2.2.3.1.14.1 Create SARSAT Hit***
  - ***2.2.3.1.14.2 Read SARSAT Hit***
  - ***2.2.3.1.14.3 Update SARSAT Hit***
  - ***2.2.3.1.14.4 Delete SARSAT Hit***
- 2.2.3.1.15 Ck: Person in Water
  - ***2.2.3.1.15.1 Create Person in Water Record***
  - ***2.2.3.1.15.2 Read Person in Water Record***
  - ***2.2.3.1.15.3 Update Person in Water Record***
  - ***2.2.3.1.15.4 Delete Person in Water Record***
- 2.2.3.1.16 Ck: Vessel Stuck in Ice
  - ***2.2.3.1.16.1 Create Vsl Stuck in Ice Record***
  - ***2.2.3.1.16.2 Read Vsl Stuck in Ice Record***
  - ***2.2.3.1.16.3 Update Vsl Stuck in Ice Record***
  - ***2.2.3.1.16.4 Delete Vsl Stuck in Ice Record***
- 2.2.3.1.17 Ck: Vessel Collision
  - ***2.2.3.1.17.1 Create Vsl Collision Record***
  - ***2.2.3.1.17.2 Read Vsl Collision Record***
  - ***2.2.3.1.17.3 Update Vsl Collision Record***
  - ***2.2.3.1.17.4 Delete Vsl Collision Record***
- 2.2.3.1.18 Ck: Vessel Fire
  - ***2.2.3.1.18.1 Create Vsl Fire Record***
  - ***2.2.3.1.18.2 Read Vsl Fire Record***
  - ***2.2.3.1.18.3 Update Vsl Fire Record***
  - ***2.2.3.1.18.4 Delete Vsl Fire Record***

2.2.3.2 ELT Checklists
- 2.2.3.2.1 Ck: Zero Tolerance
  - ***2.2.3.2.1.1 Create Zero Tolerance Record***
  - ***2.2.3.2.1.2 Read Zero Tolerance Record***
  - ***2.2.3.2.1.3 Update Zero Tolerance Record***
  - ***2.2.3.2.1.4 Delete Zero Tolerance Record***
- 2.2.3.2.2 Ck: Vessel Seizure
  - ***2.2.3.2.2.1 Create Vsl Seizure Record***
  - ***2.2.3.2.2.2 Read Vsl Seizure Record***
  - ***2.2.3.2.2.3 Update Vsl Seizure Record***
  - ***2.2.3.2.2.4 Delete Vsl Seizure Record***
- 2.2.3.2.3 Ck: Marine Mammal Incident
  - ***2.2.3.2.3.1 Create Marine Mammal Record***
  - ***2.2.3.2.3.2 Read Marine Mammal Record***

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***2.2.3.2.3.3 Update Marine Mammal Record***
***2.2.3.2.3.4 Delete Marine Mammal Record***
2.2.3.2.4 Ck: PD27 Process
***2.2.3.2.4.1 Create PD27 Process Record***
***2.2.3.2.4.2 Read PD27 Process Record***
***2.2.3.2.4.3 Update PD27 Process Record***
***2.2.3.2.4.4 Delete PD27 Process Record***
2.2.3.2.5 Ck: Border Search Authority
***2.2.3.2.5.1 Create Border Search Record***
***2.2.3.2.5.2 Read Border Search Record***
***2.2.3.2.5.3 Update Border Search Record***
***2.2.3.2.5.4 Delete Border Search Record***
2.2.3.2.6 Ck: AMIO Incident
***2.2.3.2.6.1 Create AMIO Incident Record***
***2.2.3.2.6.2 Read AMIO Incident Record***
***2.2.3.2.6.3 Update AMIO Incident Record***
***2.2.3.2.6.4 Delete AMIO Incident Record***
2.2.3.3 General Cmd Ctr Checklists
2.2.3.3.1 Ck:Explosive Ordnance Disposal
***2.2.3.3.1.1 Create EOD Record***
***2.2.3.3.1.2 Read EOD Record***
***2.2.3.3.1.3 Update EOD Record***
***2.2.3.3.1.4 Delete EOD Record***
2.2.3.3.2 Ck: Asylum Requests
***2.2.3.3.2.1 Create Asylum Request Record***
***2.2.3.3.2.2 Read Asylum Request Record***
***2.2.3.3.2.3 Update Asylum Request Record***
***2.2.3.3.2.4 Delete Asylum Request Record***
2.2.3.3.3 Ck: Oil Pollution Reports
***2.2.3.3.3.1 Create Oil Pollution Record***
***2.2.3.3.3.2 Read Oil Pollution Record***
***2.2.3.3.3.3 Update Oil Pollution Record***
***2.2.3.3.3.4 Delete Oil Pollution Record***
2.2.3.3.4 Ck: HazMat Reports
***2.2.3.3.4.1 Create HazMat Report Record***
***2.2.3.3.4.2 Read HazMat Report Record***
***2.2.3.3.4.3 Update HazMat Report Record***
***2.2.3.3.4.4 Delete HazMat Report Record***
2.2.3.4 Boat Ops Checklists
***2.2.3.4.1 Crew Brief***
***2.2.3.4.2 Passenger Brief***
***2.2.3.4.3 Medical Debrief***
***2.2.3.4.4 Survivor Debrief***
***2.2.3.4.5 Rescue Brief***
***2.2.3.4.6 Dewatering Checklist***
***2.2.3.4.7 Firefighting Checklist***
2.2.3.5 Acft Ops Checklists
***2.2.3.5.1 Pre-flight Checklist***
***2.2.3.5.2 Post-flight Checklist***
***2.2.3.5.3 Approach Brief***
***2.2.3.5.4 Hoist Brief***
***2.2.3.5.5 PATCH Brief***
***2.2.3.5.6 MATCH Brief***
2.2.3.5.7 Crew Brief
2.2.3.5.8 Passenger Brief
2.2.3.5.9 Medical Debrief
2.2.3.5.10 Survivor Debrief
2.2.3.5.11 Rescue Briefing
2.2.3.5.12 Emergency Action Checklist
2.2.4 Reference
2.2.4.1 Official Policy Information
***2.2.4.1.1 Import ASCII Text of Policy***

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## COMPONENT / TRANSACTION

- 2.2.4.1.2 ***Create Index Entry for Policy***
- 2.2.4.1.3 ***Search Policy Index***
- 2.2.4.1.4 ***Display ASCII Text of Policy***
- 2.2.4.2 Local Guidance (Hotword)
- 2.2.4.2.1 ***Import ASCII Text of Hotword***
- 2.2.4.2.2 ***Direct Hotword Data Entry***
- 2.2.4.2.3 ***Create Index Entry for Hotword***
- 2.2.4.2.4 ***Search Hotword Index***
- 2.2.4.2.5 ***Display ASCII Text of Hotword***
- 2.2.5 Weather
- 2.2.5.1 ***Create Weather Record***
- 2.2.5.2 ***Read Weather Record***
- 2.2.5.3 ***Update Weather Record***
- 2.2.5.4 ***Delete Weather Record***
- 2.2.5.5 ***Filter Weather Records***
- 2.2.5.6 ***Display Weather List Report***
- 2.2.5.7 ***Display Weather Records in GIS***
- 2.3 Analyze Information: Reports
- 2.3.1 ***Display/Print Situation Summ***
- 2.3.2 ***Display/Print Critical Info***
- 2.3.3 ***Display/Print New Data***
- 2.3.4 ***Display/Print Changes***
- 2.3.5 ***Display/Print Data Conflicts***
- 2.3.6 ***Display/Print Resource Status***
- 2.3.7 ***Display/Print Active Sit List***
- 2.3.8 ***Display/Print Sit Summ Report***
- 2.3.9 ***Adhoc Query Active/Archived***
- 2.4 Plan Operation
- 2.4.1 ***Assign SMC/MC***
- 2.4.2 Create Search Area
- 2.4.2.1 ***Select Targets***
- 2.4.2.2 ***Define Search Area***
- 2.4.2.3 ***Create Search Area Record***
- 2.4.2.4 ***Read Search Area Record***
- 2.4.2.5 ***Update Search Area Record***
- 2.4.2.6 ***Delete Search Area Record***
- 2.4.2.7 ***Filter Search Area Records***
- 2.4.2.8 ***Display Search Areas List Rpt***
- 2.4.2.9 ***Display Search Areas in GIS***
- 2.4.3 Create Tasking Record
- 2.4.3.1 ***Select Targets***
- 2.4.3.2 ***Select Resources***
- 2.4.3.3 ***Assign Resources to Case***
- 2.4.3.4 ***Create Tasking Record***
- 2.4.3.5 ***Read Tasking Record***
- 2.4.3.6 ***Update Tasking Record***
- 2.4.3.7 ***Delete Tasking Record***
- 2.4.3.8 ***Filter Tasking Records***
- 2.4.3.9 ***Display Tasking Record ListRpt***
- 2.4.3.10 ***Display Tasking Records in GIS***
- 2.4.4 Allocate Resources
- 2.4.4.1 ***Select Targets***
- 2.4.4.2 ***Select Search Areas***
- 2.4.4.3 ***Create Resource Alloc Record***
- 2.4.4.4 ***Read Resource Alloc Record***
- 2.4.4.5 ***Update Resource Alloc Record***
- 2.4.4.6 ***Delete Resource Alloc Record***
- 2.4.4.7 ***Filter Resource Alloc Records***
- 2.4.4.8 ***Display Resource Alloc ListRpt***
- 2.4.4.9 ***Display Resource Alloc in GIS***
- 2.5 Conduct Operation
- 2.5.1 Resource Events

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- ***2.5.1.1 Create Resource Event***
- ***2.5.1.2 Read Resource Event***
- ***2.5.1.3 Update Resource Event***
- ***2.5.1.4 Delete Resource Event***
- ***2.5.1.5 Evolve Resource Event***
- ***2.5.1.6 Filter Resource Events***
- ***2.5.1.7 Display Resource Event ListRpt***
- ***2.5.1.8 Display Resource Events in GIS***

2.5.2 SAR Information
- 2.5.2.1 CASP Information
  - 2.5.2.1.1 Search Results
    - ***2.5.2.1.1.1 Create Search Result Record***
    - ***2.5.2.1.1.2 Read Search Result Record***
    - ***2.5.2.1.1.3 Update Search Result Record***
    - ***2.5.2.1.1.4 Delete Search Result Record***
    - ***2.5.2.1.1.5 Filter Search Result Record***
    - ***2.5.2.1.1.6 Display Search Results ListRpt***
    - ***2.5.2.1.1.7 Display Search Results in GIS***
  - 2.5.2.1.2 Track History
    - ***2.5.2.1.2.1 Create Track History Record***
    - ***2.5.2.1.2.2 Read Track History Record***
    - ***2.5.2.1.2.3 Update Track History Record***
    - ***2.5.2.1.2.4 Delete Track History Record***
    - ***2.5.2.1.2.5 Filter Track History Records***
    - ***2.5.2.1.2.6 Display Track History ListRpt***
    - ***2.5.2.1.2.7 Display Track Histories in GIS***
- 2.5.2.2 SAR Summary Information
  - ***2.5.2.2.1 Create SAR Summary Record***
  - ***2.5.2.2.2 Read SAR Summary Record***
  - ***2.5.2.2.3 Update SAR Summary Record***
  - ***2.5.2.2.4 Delete SAR Summary Record***
  - ***2.5.2.2.5 Filter SAR Summary Records***
  - ***2.5.2.2.6 Display SAR Summary List Rpt***
  - ***2.5.2.2.7 Display SAR Summary in GIS***

2.5.3 LE Information
- 2.5.3.1 Boarding Information
  - ***2.5.3.1.1 Create Boarding Record***
  - ***2.5.3.1.2 Read Boarding Record***
  - ***2.5.3.1.3 Update Boarding Record***
  - ***2.5.3.1.4 Delete Boarding Record***
  - ***2.5.3.1.5 Filter Boarding Records***
  - ***2.5.3.1.6 Display Local Boarding List***
  - ***2.5.3.1.7 Display Boardings in GIS***
- 2.5.3.2 Sighting Information
  - ***2.5.3.2.1 Create Sighting Record***
  - ***2.5.3.2.2 Read Sighting Record***
  - ***2.5.3.2.3 Update Sighting Record***
  - ***2.5.3.2.4 Delete Sighting Record***
  - ***2.5.3.2.5 Filter Sighting Records***
  - ***2.5.3.2.6 Display Local Sighting List***
  - ***2.5.3.2.7 Display Local Sightings in GIS***
- 2.5.3.3 Violation Information
  - ***2.5.3.3.1 Create Violation Record***
  - ***2.5.3.3.2 Read Violation Record***
  - ***2.5.3.3.3 Update Violation Record***
  - ***2.5.3.3.4 Delete Violation Record***
  - ***2.5.3.3.5 Filter Violation Records***
  - ***2.5.3.3.6 Display Local Violation List***
  - ***2.5.3.3.7 Display Loc Violations in GIS***
- 2.5.3.4 Detection Information
  - ***2.5.3.4.1 Create Detection Record***
  - ***2.5.3.4.2 Read Detection Record***

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- ***2.5.3.4.3 Update Detection Record***
- ***2.5.3.4.4 Delete Detection Record***
- ***2.5.3.4.5 Filter Detection Records***
- ***2.5.3.4.6 Display Local Detection List***
- ***2.5.3.4.7 Display Local Detects in GIS***
- 2.5.3.5 Lookout Information
- ***2.5.3.5.1 Import LEIS II Lookout List***
- ***2.5.3.5.2 Read Lookout List***
- ***2.5.3.5.3 Search Lookout List***
- ***2.5.3.5.4 Filter Lookout List***
- ***2.5.3.5.5 Display Lookout List***
- ***2.5.3.5.6 Display Lookout List in GIS***
- 2.5.4 Chrono Note
- ***2.5.4.1 Create Chrono Notes***
- ***2.5.4.2 Read Chrono Notes***
- ***2.5.4.3 Update Chrono Notes***
- ***2.5.4.4 Delete Chrono Notes***
- ***2.5.4.5 Filter Chrono Notes***
- ***2.5.4.6 Display Chrono Notes List Rpt***
- 2.5.5 OpNotes (free text notes)
- ***2.5.5.1 Create OpNotes***
- ***2.5.5.2 Read OpNotes***
- ***2.5.5.3 Update OpNotes***
- ***2.5.5.4 Delete OpNotes***
- ***2.5.5.5 Filter OpNotes***
- ***2.5.5.6 Display OpNotes List Rpt***
- 2.5.6 Crew Events
- ***2.5.6.1 Create Crew Events***
- ***2.5.6.2 Read Crew Events***
- ***2.5.6.3 Update Crew Events***
- ***2.5.6.4 Delete Crew Events***
- ***2.5.6.5 Filter Crew Events***
- ***2.5.6.6 Display Crew Event Report***
- 2.6 Conclude Operation
- 2.6.1 Validation Situation Data
- ***2.6.1.1 Determine Employ Categories***
- ***2.6.1.2 Determine Resource Events***
- ***2.6.1.3 Apply Ruleset 1***
- ***2.6.1.4 Apply Ruleset 2***
- ***2.6.1.5 Apply Ruleset 3***
- ***2.6.1.6 Apply Ruleset 4***
- ***2.6.1.7 Apply Ruleset 5***
- ***2.6.1.8 Apply Ruleset 6***
- ***2.6.1.9 Apply Ruleset 7***
- ***2.6.1.10 Apply Ruleset 8***
- ***2.6.1.11 Build Validation Screen***
- ***2.6.1.12 Commit Validation Changes***
- 2.7 Debrief Ops (see Checklists)
- 2.8 Document Operation
- 2.8.1 Resource Employment Tracking
- ***2.8.1.1 Search Resource Employ Data***
- ***2.8.1.2 Specify Resource Employ Dates***
- ***2.8.1.3 Create Resource Employ Record***
- ***2.8.1.4 Export Resource Employ Data***
- 2.8.2 Populate External Systems
- 2.8.2.1 Export Board Rpt to ProcCen
- ***2.8.2.1.1 Export USCG Unit Data***
- ***2.8.2.1.2 Export Vessel Data***
- ***2.8.2.1.3 Export Person Data***
- ***2.8.2.1.4 Export Boarding Data***
- ***2.8.2.1.5 Export Violation Data***
- 2.8.2.2 Export SABR to LEIS II

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**COMPONENT / TRANSACTION**

2.8.2.2.1 ***Export USCG Unit Data***
2.8.2.2.2 ***Export Vessel Data***
2.8.2.2.3 ***Export Person Data***
2.8.2.2.4 ***Export Sighting Data***
2.8.2.2.5 ***Export Boarding Data***
2.8.2.2.6 ***Export Violation Data***
2.8.2.2.7 ***Export Detection Data***
2.8.2.3 Export Data to SARMIS
2.8.2.3.1 ***Export SARMIS "A" Record***
2.8.2.3.2 ***Export SARMIS "B" Record***
2.8.2.3.3 ***Export SARMIS "C" Record***
2.8.2.3.4 ***Export SARMIS "D" Record***
2.8.2.4 Export Qtrly Aops Rpt to Aops
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2.8.2.5 ***Create Draft SITREP***
2.9 Time Zone Conversion Algorithm
2.9.1 ***Local to Zulu before DB commit***
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3 Manage Communications
3.1 Shore Comms Module
3.1.1 Shore Comms Transmit Module
3.1.1.1 ***Retrieve Data for Datagram***
3.1.1.2 ***Write data to Datagram***
3.1.1.3 ***Compress Datagram***
3.1.1.4 ***Encrypt Datagram***
3.1.1.5 ***Transmit Datagram using EDAC***
3.1.2 Shore Comms Receive Module
3.1.2.1 ***Receive Datagram***
3.1.2.2 ***Decrypt Datagram***
3.1.2.3 ***Decompress Datagram***
3.1.2.4 ***Parse data out of Datagram***
3.1.2.5 ***Send data to update process***
3.2 Boat Comms Module
3.2.1 Boat Comms Transmit Module
3.2.1.1 ***Retrieve Data for Datagram***
3.2.1.2 ***Write data to Datagram***
3.2.1.3 ***Compress Datagram***
3.2.1.4 ***Encrypt Datagram***
3.2.1.5 ***Transmit Datagram using EDAC***
3.2.2 Boat Comms Receive Module
3.2.2.1 ***Receive Datagram***
3.2.2.2 ***Decrypt Datagram***
3.2.2.3 ***Decompress Datagram***
3.2.2.4 ***Parse Data out of Datagram***
3.2.2.5 ***Send Data to update process***
3.3 Aircraft Comms Module
3.3.1 Aircraft Comms Transmit Module
3.3.1.1 ***Retrieve Data for Datagram***
3.3.1.2 ***Write data to Datagram***
3.3.1.3 ***Compress Datagram***
3.3.1.4 ***Encrypt Datagram***
3.3.1.5 ***Transmit Datagram using EDAC***
3.3.2 Aircraft Comms Receive Module
3.3.2.1 ***Receive Datagram***
3.3.2.2 ***Decrypt Datagram***
3.3.2.3 ***Decompress Datagram***

## *HIERARCHY OUTLINE LIST*

| | | |
|---|---|---|
| USCG Operational Info System<br>FY97RCP | Application Development<br>Development Project | AC&I Development |

**COMPONENT / TRANSACTION**

- ***3.3.2.4 Parse Data out of Datagram***
- ***3.3.2.5 Send Data to update process***

4 Manage System
- 4.1 Manage User Accounts
  - ***4.1.1 Create User Account***
  - ***4.1.2 Read User Account***
  - ***4.1.3 Update User Account***
  - ***4.1.4 Delete User Account***
- 4.2 Control Access
  - ***4.2.1 Get Username and Password***
  - ***4.2.2 Check Username and Password***
  - ***4.2.3 Start Application***
  - ***4.2.4 Redisplay Logon Screen***
  - ***4.2.5 Write Logon Attempt to Aud Log***
- 4.3 Set System Defaults
  - ***4.3.1 Set Default OPFAC and Resource***
  - ***4.3.2 Set Default OPCON***
  - ***4.3.3 Set Time Zone***
  - ***4.3.4 Set Default Chart***

5 On-line Help
- ***5.1 Help Screens***
- ***5.2 Help System Indexing***
- ***5.3 Help System Topic Assignments***
- ***5.4 Help System Example Data Sets***
- ***5.5 Help System Hypertext Links***
- ***5.6 Help System Context IDs***
- ***5.7 Help System Status Bars***
- ***5.8 Help System Tool Tips***
- ***5.9 Help System Balloon Help***

6 VTS2000 Interface Placeholder

7 MSN Interface Placeholder

8 Multi-Level Security Placehold

# APPENDIX D: OIS PHASE I AND II COST ESTIMATE

Cost estimates are considered Procurement Sensitive Information, release of which could detract from full and open competition in future acquisitions involving OIS. Therefore, this appendix has been deleted from the publicly available version of this report.

# APPENDIX E: COAST GUARD OPERATIONAL COMMUNICATIONS COST MODEL

Cost estimates are considered Procurement Sensitive Information, release of which could detract from full and open competition in future acquisitions involving OIS. Therefore, this appendix has been deleted from the publicly available version of this report.

# APPENDIX F: BENEFITS ANALYSIS FOR OIS PHASES I AND II

This appendix is included in order to extrapolate the quantifiable benefits measured during the Group/Station OIS Testbed to Phase II. The analysis is based on the Functional Decomposition in Appendix F, which is summarized in Table 13. The primary functional difference between Phase I and Phase II is the additional integration of Computer Aided Search Planning System (CASP). The primary resource difference is the addition of Cutters, Aircraft, District and Area command centers. This would involve developing an additional mobile subsystem, optimized for aircraft use. However, higher level command centers would use the same command center system as developed for Group/Station OIS. Cutters would also use the same system as shoreside command centers. The Benefits Analysis has been prepared in accordance with guidelines in the Coast Guard's draft *Benefit-Cost Analysis Manual for the Acquisition of Federal Information Processing (FIP) Resources*, COMDTINST M7110.1.

Table 13: Major OIS Phase I and II functions.

| Shoreside Subsystem | Aircraft Subsystem | Utility Boat Subsystem |
|---|---|---|
| Geographic Information System to integrate operational information | | Electronic Chart System to improve navigational accuracy |
| Data entry, including source data capture (requires fast response for use during ops) | Source data capture, during SAR and sightings, via pen-based computer | Source data capture, during SAR and boardings, via pen-based computer |
| Data distribution, allowing all units access to shared case information, and resolving conflicts between updates | Data distribution | Data distribution |
| Integrated Search Planning (CASP) | Integrated search pattern receipt from command center, execution, and tracking | Integrated search pattern receipt from command center, execution, and tracking |
| Electronic checklists | Electronic checklists | Electronic checklists |
| Resource and facility tracking via GIS | Remote Dependent Surveillance System (RDSS) for ops and position reporting | Remote Dependent Surveillance System (RDSS) for ops and position reporting |
| Validation to verify completeness and accuracy for external systems. | Validation | Validation |
| Operational reports consolidation and export to external systems | Automatic Report Generation | Automatic Report Generation |
| Online access to LEIS II information | Online access to LEIS II information | Online access to LEIS II information |
| Electronic tasking to resources | Electronic tasking and status reporting | Electronic tasking and status reporting |
| Integrated Decisions Aids | Integrated Decisions Aids, such as regulation references on-line | Integrated Decisions Aids, such as regulation references on-line |

Table 14 summarizes the annual and life cycle benefits attributable to the Operational Information System, Phases I and II. As with the Phase I Benefits Analysis in Chapter 6, this table includes only benefits which could be measured based on the research done to date. It does not project benefits which could be derived from business process reengineering enabled by OIS. The first set of benefits are those which are directly quantifiable, *and* capturable within the Coast Guard budget as either direct cost savings or cost avoidances. The second set of benefits are quantified, but cannot be captured within the Coast Guard budget. For instance, reports reduction will save our field personnel from working overtime. However, since military personnel are not compensated for overtime work, this does not present a benefit that can be captured in the budget. It is likely to produce long-term benefits such as better retention because of improved working conditions, reduced health care cost because of lowered stress, and similar work-life concerns

Table 14: OIS Phase I and II benefit summary, in millions of dollars.

| Benefit Type | Benefit Description | One-Time Benefit ($M) | Annual Benefit ($M) | Total Life Cycle Benefit ($M) |
|---|---|---|---|---|
| **Monetizable Benefits (Direct Cost Avoidance or Savings)** | | | | |
| | Avoidance of accidental collisions and groundings | | $2.0 | $20.0 |
| | Subtotal, Monetizable Benefits ($M) | **$0.0** | **$2.0** | **$20.0** |
| **Non-Monetizable Benefits (Indirect Cost Avoidance or Benefits to Society in General)** | | | | |
| | Report Reduction | | $1.1 | $11.0 |
| | Improved Search Accuracy | | $13.4 | $133.6 |
| | Subtotal, Non-Monetizable Benefits ($M) | **$0.0** | **$14.5** | **$144.6** |
| **Total Benefits ($M)** | | **$0.0** | **$16.5** | **$164.6** |

## REPORTS REDUCTION

The Benefits Analysis in Chapter 6 estimates savings from reports reductions for Groups and Stations. In Table 15, these savings are extrapolated to all SAR and LE operating units. The table makes the same underlying assumptions as the earlier analysis.

Table 15: Annual benefit of operational reports reduction.

| Report Type | Minutes saved per report | Reports per year | Hours saved per year | Labor Rate | Benefit, dollars per year |
|---|---|---|---|---|---|
| SARMIS entries | 7 | 65,000 | 7,800 | 17 | $132,600 |
| SEER Messages (Boardings) | 7 | 25,000 | 2,708 | 24 | $65,000 |
| SEER Messages (Sightings) | 2 | 90,000 | 3,000 | 24 | $72,000 |
| Boarding Report (CG 4100) | 2 | 25,000 | 833 | 24 | $20,000 |
| SITREPS (10% of SAR cases) | 30 | 6,500 | 3,250 | 24 | $78,000 |
| Distress checkoff sheet | 0 | | - | 17 | $0 |
| POLREPS | 30 | 5,000 | 2,500 | 24 | $60,000 |
| Abstract of Operations Rpt | 60 | 8,000 | 8,000 | 24 | $192,000 |
| SAR Case Folder | 3 | 65,000 | 3,250 | 17 | $55,250 |
| MLE Weekly Feeder Reports | 10 | 26,000 | 4,333 | 24 | $104,000 |
| Abbreviated Radio Log | 2 | 65,000 | 2,167 | 17 | $36,833 |
| Chrono log | 0 | | - | 17 | $0 |
| Unit Underway Hours log | 1 | 100,000 | 1,667 | 17 | $28,333 |
| Weather log | 0 | | - | 17 | $0 |
| Training log | 2 | 400,000 | 13,333 | 17 | $226,667 |
| Auxiliary Orders log | 0 | | - | 17 | $0 |
| SEER log | 1 | 115,000 | 1,917 | 17 | $32,583 |
| **Totals** | | | **54,758** | | **$1,103,267** |

## IMPROVED SEARCH PRECISION

Better resource allocation and tracking improve pilot confidence, so allows more time searching for surface target and less time scanning surrounding airspace for conflicting aircraft.

The success of search efforts depends, in part, on the navigational precision of Search & Rescue Units (SRUs), particularly aircraft as they execute search patterns. For a variety of reasons, which are explained in following paragraphs, the performance of CG resources in search operations is described (from a strictly theoretical standpoint) as random. These random searches are expensive and sometimes fruitless. By improving navigational precision, the Coast Guard could make dramatic improvements in search capabilities, and lower costs. Even more important, we would expect to save more lives by (a) locating victims instead of not locating them, and (b) locating them sooner, before hypothermia and exposure have set in.

The Coast Guard's Computer Aided Search Planning system (CASP) allows command center watchstanders to generate search patterns automatically. However, these patterns must be decomposed into descriptive text and transmitted to Search and Rescue Units (SRUs) by voice or text-based methods, then re-plotted or entered in SRU navigation systems. Finally, the SRU commander must manually navigate the craft through the search pattern and report results back to the command center for effectiveness calculations. Using OIS to integrate CASP into the actual search execution instead of stopping at the planning stage would create significant improvements

in search performance. It would also make even more substantial improvements in analyzing searches that did not locate the targets, and in planning subsequent searches.

The basis for the following discussion is work done over the last twenty years by the Coast Guard's Research and Development Center, both in search effectiveness experiments and in CASP design and upgrades. These, in turn, are based largely on the search theories developed during World War II by B. O. Koopman. The resultant search planning guidelines appear in the National SAR Manual. Koopman described the search performance of visual detection with his "inverse cube law," which is based on the following conditions:

1. The primary sensor is the human eye (visual search).
2. The primary sensor platform is a patrol aircraft.
3. The search objects are large warships underway.
4. The search object is contained in the search area.
5. The search legs are exactly parallel relative to the search object (whether moving or stationary).
6. Initial detection is by sighting the vessel's wake.
7. The instantaneous probability of detection is inversely proportional to the solid angle subtended at the observer's eye by the vessel's wake.

The last assumption leads, mathematically, to the equivalent assumption that the instantaneous probability of detection is inversely proportional to the cube of the target's range from the observer. Hence, we say this visual detection model describes an "inverse cube law" sensor.

Given the characteristics of a sensor, the next obvious task is to determine how to best employ that sensor. In other words, the best tactics for using the sensor need to be determined. Koopman found that for a uniform target probability distribution within some area, any sensor which has a "peaked" lateral range curve (LRC) is best employed by covering the area with equally spaced parallel tracks. A lateral range curve describes the probability of detection as a function of range perpendicular to the sensor's track after one complete "fly-by" of the search object. The inverse cube law produces a very "peaked" lateral range curve. That is, the probability of detection very close to the sensor's track is nearly 100% and then decreases rapidly as lateral range increases. It is important to note that for moving targets, it is necessary to adjust the search legs keep them parallel <u>relative to the target</u> in order to realize the benefits of parallel path searching.

The benefits of organized, parallel path searching can be significant. To establish a basis for comparisons, we need to look at two other theoretical curves of Probability of Detection (POD) vs. Coverage Factor (CF). The first is for a "perfect" sensor. Such a sensor is said to obey a definite range law because within some specific range, detection is guaranteed while outside that range no detection ever occurs. For such a "perfect" sensor, POD equals Coverage Factor for Coverage Factors of 1.0 or less. Above 1.0, there is no additional benefit because POD is already at 100%. The other POD vs. Coverage Factor curve that needs to be considered is the so called "random search curve". This curve has a specific mathematical definition (as do the other two), but random search can be thought of as an aircraft flying a series of short random legs but staying within the search area.

The following definitions apply to further discussion:

- ***Sweep Width:*** the area under the lateral range curve (miles)
- ***Search Effort:*** the product of Sweep Width and Trackline Miles traversed by the sensor (square miles)
- ***Coverage Factor:*** the ratio of Search Effort to the Area being searched (computing Coverage Factor as the ratio of Sweep Width to Trackspacing is just a convenient mathematical shortcut valid only for parallel path search patterns)
- ***POD:*** Probability Of Detection - probability of detecting the target, given that it is in the area being searched
- ***POA:*** Probability Of the target being in the Area - also sometimes called POC (Probability Of Containment).
- ***POS:*** Probability Of Success - the probability of finding the target in the area being searched. POS is the product of POD and POA (POS = POD x POA)

At coverage factor 1.0, a definite range law sensor produces a POD of 100% for a perfect (zero navigational error) parallel path search; an inverse cube law sensor produces a POD of 78% under the same conditions; but a random search produces a POD of only about 63%. Furthermore, random search POD depends only on Coverage Factor. Either a definite range law sensor, or an inverse cube law sensor, or any other sensor, if employed in a random search pattern, will produce the same 63% POD for a Coverage Factor of 1.0.

To understand the true benefit of organized, parallel path searching, it is necessary to compare the amounts of effort required to achieve the same results using random search. To achieve a 78% POD using random search, a Coverage Factor of 1.5 is required. In other words, it takes 50% more effort to achieve the same level of search effectiveness with an inverse cube law sensor if it is employed randomly rather than in parallel paths relative to the search object. The situation is even more pronounced with a "perfect" definite range law sensor - random searching requires nearly twice the effort to achieve 78% POD as compared to parallel path searching.

So far we have been comparing extremes of search execution: perfectly executed parallel paths versus complete randomness. A key question in moving from the theoretical to the practical is, *"How rapidly does the POD deteriorate toward the random search curve as a function of deterioration in parallel path search pattern execution?"*

There are several ways in which a parallel path search pattern can be improperly executed. The first we will consider involves relatively small navigational error. In this case, the search craft begins the search correctly, within the search craft's normal navigational error of the commence search point (CSP) and stays within that distance of its intended trackline throughout the search. We may simulate the effects of such error, or search craft position uncertainty, by considering the cross-track error along the search legs. If the cross-track error is normally distributed, then we may compute the convolution of the "normal" function with the lateral range curve to get an *expected*, or average, lateral range curve for the given cross-track error. The expected POD vs. Coverage Factor curve can then be computed for this expected LRC. Such expected LRCs are less peaked than the original LRC of the sensor itself even though the areas (sweepwidths) under the two curves are identical. If the position of the sensor is uncertain relative to the intended

track, then the POD for a target on the intended track is likewise uncertain and, on average over many trials, lower. Likewise, the POD for targets a significant distance off the intended track will be raised somewhat. As the shape of the lateral range curve becomes more and more flat with a more nearly constant (but low) expected POD over a large range (i.e. the opposite of peaked), the more closely the POD vs. Coverage Factor curve approaches that of random search. If the sensor's lateral range curve is low and nearly flat, then where it is placed becomes unimportant, and hence there is little or no benefit to parallel path searching over random searching - both will produce the random search curve. If navigational error is large enough to reduce a sensor's peaked LRC down to one that is effectively low and flat, the same result - random search PODs - will occur.

For normally distributed cross-track errors, significant reductions in POD occur when the standard deviation of the crosstrack error is equal to the sweepwidth. By the time the standard deviation approaches two sweepwidths, the POD is nearly down to random search values. Since the sweepwidths for SAR targets are typically small, accurate navigation and search pattern execution are essential.

Other even more dramatic effects on POD/POS can be introduced by navigational error. The most obvious is failing to search the correct area but searching a different one instead. This is usually the result of human, rather than equipment, error. A less obvious type of error is that introduced by unintended relative motion between the target and the sensor.

Unintended relative motion can be introduced in two ways, which may both be present at the same time. First, until recently, SAR search planning doctrine did not consider the effects of target motion even though most maritime SAR targets are adrift and therefore moving. Apparently it was believed that typical rates of drift were so small compared to the speed of the search craft, especially aircraft, that target motion was insignificant. The correct values to compare, however, are the target's drift rate with the search craft's rate of creep through a parallel path search. Consider a target in the Straits of Florida moving north at four knots. An aircraft flying across the strait (approximately 60 nautical miles) at 120 knots and creeping north on a two mile trackspace would be moving north at exactly four knots. Thus, the distance between the search craft and the target would remain constant throughout the search! The POD, therefore, would be very high if the target was on or near the search craft's initial search leg and very low otherwise. Thus, the POD for targets in the vast majority of the search area at commence search time would be very low, driving the POS for the intended search area down to a correspondingly low value. For ten search legs (a five hour search) and a coverage factor of 1.0, the POD would be on the order of 10 percent because all the search effort was concentrated in roughly 10 percent of the intended search area relative to the target. In this case, a perfectly executed parallel path search would produce results well below the random search curve.

A first-order correction to this type of problem is to orient the search legs in the direction of target motion to minimize its impact on the trackspacing and parallelism of the search legs and area covered relative to the target's predicted motion. A refinement is to skew the normally rectangular search areas into parallelograms to compensate for target motion during the search. Another technique is to use a barrier search pattern with search legs roughly perpendicular to the direction of drift which compensate for predicted target motion. This latter technique is not

recommended due to the sensitivity of the actual trackspacing and parallelism of the search legs, the area covered, and hence the POD, to variations and uncertainties in the target's motion.

The second way unintended relative motion between the sensor and the target can be introduced is through navigational error. If the search craft fails to correctly compensate for set and drift and leeway (vessels) or cross winds (aircraft), then systematic pattern errors, like those introduced by a failure to compensate for target motion, will be introduced with the same devastating effects on POD.

Given the numerous sources of search pattern error (general navigational error, diverting to investigate sightings, systematic/cumulative errors, etc.) when looking for targets whose motion can be predicted with only limited accuracy, a strong case can be made for discarding our present inverse-cube-law-based POD vs. Coverage Factor curve in favor of the random search curve. In fact, given the devastating systematic pattern errors discussed above, the random search curve may well be the best we have any right to expect. To justify using any more optimistic POD vs. Coverage Factor curve, the Coast Guard needs more accurate navigational techniques and computer assistance which can aid the search planner in developing, and the SRU in accurately executing, search plans for moving targets. For PIW searches, this might even require development and deployment of navigational DMBs which an SRU would use as navigational aids to execute a parallel path search relative to the moving water, rather than relative to the fixed bottom. In fact, a small boat in a tidal region navigating by DR without regard to set and drift is probably doing a better search for a PIW than one using very accurate navigational aids to precisely execute a parallel path search relative to the ground.

For parallel path searches using an inverse cube law sensor, the probability of detection can be calculated using

Equation 1: POD = erf (0.8862 x CF)

where CF is equal to the coverage factor (track space divided by track spacing), 0.8862 is equal to the square root of pi divided by 2, and erf is the error function which can be found in the probability tables of most mathematical handbooks.

For random searching, the POD can be calculated using the following formula:

Equation 2: POD = 1 - e-CF

The problem with these laws is that they no longer apply when the SAR target drifts out of the search area. For the purposes of discussing improvements to search performance through search craft navigational precision, however, the POA is not material. The discussion must in fact assume that the target is always in the intended search area, i.e., POA = 100%.

Table 16 summarizes the benefits of using improved navigational precision. The table shows that improved navigation could increase search effectiveness by 24% without expending additional

resources. The table was based the 1990 Abstract of Operations for aircraft, and from COMDTINST 7310.1E (standard rates).

Table 16: Annual benefit due to increased SRU navigational precision.

| USCG Operating Platform | Annual SAR Sortie Hrs | Annual Search Hrs | Operating Cost per hour | Annual Search Dollars, Millions | Benefit due Improved Accuracy, Millions |
|---|---|---|---|---|---|
| HC-130H | 3,830 | 1,163 | 4,081 | $4.7 | $2.4 |
| HU-25 | 3,846 | 999 | 3,785 | $3.8 | $1.9 |
| HH-60J | 4,530 | 1,588 | 3,660 | $5.8 | $2.9 |
| HH-65A | 9,946 | 2,823 | 3,638 | $10.3 | $5.1 |
| WAGB | | | 3,140 | $0.0 | $0.0 |
| WHEC | 497 | 24 | 2,521 | $0.1 | $0.0 |
| WMEC | 2,786 | 247 | 1,427 | $0.4 | $0.2 |
| WLB | 995 | | 1,034 | $0.0 | $0.0 |
| WLM | | | 782 | $0.0 | $0.0 |
| WTGB | 1,381 | | 887 | $0.0 | $0.0 |
| WYTL | | | 296 | $0.0 | $0.0 |
| WPB | 25,114 | | 493 | $0.0 | $0.0 |
| MLB | 9,030 | 579 | 403 | $0.2 | $0.1 |
| UTB | 36,333 | 3,178 | 299 | $1.0 | $0.5 |
| RHIB | 6,638 | 664 | 223 | $0.1 | $0.1 |
| UTL | 13,362 | 1,229 | 290 | $0.4 | $0.2 |
| BU/BUSL | | | 381 | $0.0 | $0.0 |
| | | | | **$26.7** | **$13.4** |

Each resource class spends a substantial amount of time per year searching, as indicated in the third column of the table. Multiplying the third column times the fourth column gives the annual cost of searching for each resource class. As explained in the preceding paragraphs, this searching is theoretically random, where POD = 63% at CF = 1. Then the total annual cost of searches is $68.9M.

In order to increase the level of effort so that the POD would equal 78%, under random search conditions we would have to increase the coverage factor to CF = 1.5. This would require a 50% increase in operating costs, or $34.5M. If we could improve our search performance to that which is described by the inverse cube law, we would be able to achieve a POD of 78% without having to spend the additional 34.5 million dollars.

The preceding analysis assumed 100% probability of containment of the target in the search area (POA = 100%). In actuality this is not the case, since SRUs sometimes stray into search areas where the POA is low or even zero. They have even been known to miss the intended search area altogether. These problems all stem from navigational error. Since probability of success (POS) is

equal to POD times POA, POS degrades rapidly as POA is reduced. This makes the actual benefits of improved precision even greater.

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# APPENDIX G: SOFTWARE DEVELOPMENT COST ESTIMATE DETAILS FROM CHECKPOINT, OIS PHASE I

Cost estimates are considered Procurement Sensitive Information, release of which could detract from full and open competition in future acquisitions involving OIS. Therefore, this appendix has been deleted from the publicly available version of this report.

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# APPENDIX H: SOFTWARE DEVELOPMENT COST ESTIMATE DETAILS FROM CHECKPOINT, OIS PHASE II

Cost estimates are considered Procurement Sensitive Information, release of which could detract from full and open competition in future acquisitions involving OIS. Therefore, this appendix has been deleted from the publicly available version of this report.